U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

AN EVALUATION OF THE
NATIONAL EUTROPHICATION SURVEY
DATA

WORKING PAPER NO. 900

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON
and
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

An Evaluation of the National Eutrophication Survey Data

Working Paper No. 900

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by

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National Eutrophication Survey
Office of Research and Development
U. S. Environmental Protection Agency

June 1977

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I. CONCLUSIONS

Because of the nation-wide scope of the National Eutrophication Survey and the time frame of less than four years for the completion of the sampling of 812 lakes and reservoirs, 4,000+ tributary sites, and over 800 municipal wastewater treatment plants, the Survey sampling program necessarily deviated from what ordinarily would be considered an ideal experimental design. As the Survey progressed, and to the degree permitted by the day-to-day work load, limited comparisons of Survey results with results published by others on the same water bodies were made. More recently, in response to the concerns of the Ecology Advisory Committee of the Environmental Protection Agency's Science Advisory Board as to the credibility of the Survey data, a concerted effort has been made to test the validity of the data.

As a result of this effort, it is concluded that the reliability of the Survey data is better than would have been expected and that data sound enough to fulfill certain of the legislative mandates of Public Law 92-500 can be obtained with much less intensive and costly studies than previously thought necessary.

Specifically, it is concluded that:

1. The Survey water-body data compare very well with the reported data reviewed, considering the expected variability in such data.

2. The trophic condition of most lakes and reservoirs can be adequately assessed on the basis of three periods of open-water sampling.

3. Whether nitrogen, phosphorus, or some other element is limiting primary productivity in a water body can be inferred from algal assay results and nitrogen to phosphorus ratios.

4. Considering temporal and spatial variability in nutrient concentrations, the Survey tributary nutrient data compare very well with the data reported by others.

5. For the purposes of the Survey, tributary nutrient loads were determined with acceptable accuracy with a sampling frequency of 14 times per year and flow data provided by the U.S. Geological Survey.

6. The Survey tributary total phosphorus loads and the in-water-body total phosphorus concentrations are highly correlated.

7. The effluent total phosphorus loads measured at 801 municipal wastewater treatment plants are in good agreement with expected values.

II. INTRODUCTION

Largely as a result of the considerable controversy over the removal of phosphates in detergents, late in 1971, William D. Ruckleshaus, then the Administrator, committed the Environmental Protection Agency (EPA) to a nationwide assessment of the impact of phosphorus in municipal waste treatment plant discharges on freshwater lakes and reservoirs. For this purpose, the Office of Research and Development initiated the National Eutrophication Survey (NES) in early 1972 with the objectives of (1) identifying those lakes and reservoirs in the contiguous United States that receive nutrients from the discharges of municipal waste treatment facilities, (2) determining the effect of those point-source nutrient inputs on the nutrient levels and primary productivity of the water bodies, and (3) on the basis of that information, advising the Construction Grants Program of the then Office of Air and Water Programs on the cost-effective allocation of Federal funds for the construction of tertiary waste treatment facilities for phosphorus removal. Following the passage of amendments to the Federal Water Pollution Control Act in October, 1972 (Public Law 92-500), the NES objectives were broadened to include an assessment of the relationships of non-point sources (e.g., land use) to lake nutrient levels and also to assist in establishing water-quality criteria for nutrients.

In August, 1975, members of the Ecology Advisory Committee of EPA's Science Advisory Board visited the Corvallis Environmental Research Laboratory (CERL) to evaluate the ecological research programs of the Laboratory, including the National Eutrophication Survey - although as the name indicates, the NES was not conceived or conducted as a research program.

After a review of the Survey by several members of the Committee, an advisory statement was submitted to the Office of Research and Development, EPA, Washington, DC. The full text of the statement is appended; the specific recommendations were:

"In order to strengthen the credibility of the study, the Committee recommends that:

- The National Lake Survey data should be compared with existing data on the many well-studied lakes of similar type.
- The comparisons of the results should be discussed in personal conference with limnologists who have collected and assessed data on the same or similar lakes and impoundments covered by the National Lake Survey.
- The National Lake Survey estimation techniques should be applied to data already available on additional well-studied lakes and impoundments and those results should be compared. This will enable one to test the degree of error one may expect to find and thus provide an evaluation of the reliability of the Survey itself.

° Only after such comparison should further efforts at extrapolation and generalization through the computer be carried out."

Subsequently, a report on the Committee's assessment of the ecological research programs, dated July 26, 1976, was submitted to EPA. The portion of the report relating to the NES follows:

"4. AQUATIC STUDIES

a. Lake Eutrophication Survey

The Lake Eutrophication Survey involved characterization of 800 lakes and reservoirs by means of a helicopter and taking very few samples at each lake or reservoir. Some parts of the Survey (National Lake Survey) were very poorly designed, and it is questionable that the Survey will yield reliable results. A program designed to yield the maximum amount of information about a series of lakes from a few samples should have begun by a detailed analysis of lakes already intensively studied. By pretending to sample these lakes at infrequent intervals it would have been possible to determine (a) the best times to take samples, and (b) the extent of information loss resulting from the low level of sampling effort. From this information the potential value of the Survey could have been estimated and decisions made about the kinds of data most worth gathering. Failure to do this means that the characterization of the lakes is subject to biases that are unknown and cannot be reliably estimated. There is no way to judge the quality of the samples or their analyses, but the Committee can say positively that the lakes selected for sampling are not representative. One way to make this program more credible would be for individuals studying these various lakes to consult with scientists who have previous data on the same lakes to correlate their findings. The Committee was concerned that there would be a considerable effort to generalize from this Survey and that its admonitions to consult with limnologists to compare old and new data on the same lake would not be taken very seriously unless the Committee's objections were recognized at the Laboratory Director level or above. The Committee agreed that EPA should be very cautious about publication of results of this study. As an outcome of the Committee's concern, ECOLOGY ADVISORY STATEMENT -- THE NATIONAL LAKE SURVEY, October 23, 1975, (APPENDIX F) was forwarded to the attention of the Assistant Administrator for Research and Development.

> Members of the Committee discussed the possibility of EPA's initiating a periodic study on lakes in the context of their watersheds or drainage areas. Several lake-watershed areas could be selected in various parts of the country with different geologic substrates and developed into experimental basins. Testing of hypotheses by experimentation is clearly the best and most efficient way to develop sound management plans. As it stands, EPA's approach appears to be entirely piecemeal, or to try something and see what happens, instead of designing studies to test previously developed hypotheses."

It is the purpose of this report to respond to the recommendations of the Committee. This has proven to be a somewhat difficult and at times frustrating undertaking primarily because the number of usable lake data pairs is quite limited, and the suggested comparison of data on water bodies of "similar type" would not be expected to yield meaningful results; e.g., the chain of Wisconsin lakes known as the Madison Lakes are well-studied and are of similar type as to origin, latitude-longitude, and drainage basin; but each is distinctive, and the quality or characteristics of one cannot readily be inferred from the data available on one or more of the others. Also, budgetary constraints have not permitted the recommended "...personal conference with limnologists who have collected and assessed data on the same or similar lakes and impoundments..."; however, we have had correspondence and telephone conversations with a number of such individuals, particularly in the preliminary-report phase of the NES.

While comparable lake data are sparse, even fewer comparable data are available on measured tributary nutrient loads and point-source/non-point-source contributions to those loads. In only one of the reports reviewed was the method of calculation of loads given, and in others the nutrient loads reported are estimates based on factors such as land use (categorized or generalized), animal densities, population densities (usually the latest Census at the time the report was written), etc., but often different assumptions were used as to the relative nutrient flux attributable to each of the factors since "...considerable variation exists in the quantities of nutrients that are exported from 'similar' areas devoted to the same use" (Uttormark et al., 1974; pg. 100).

III. METHODS AND OPERATION OF THE SURVEY

Freshwater lakes and impoundments in the Survey were selected through consultation with EPA Regional Offices and state pollution control agencies, as well as related state agencies managing fisheries, water resources, or public health. EPA established selection criteria to limit the type and number of candidate water bodies, consistent with existing Agency water goals and strategies. For 27 states of the eastern United States where lakes were selected prior to passage of PL 92-500, strongest emphasis was placed on lakes faced with actual or potential accelerated eutrophication problems; e.g., an increased rate of algal and/or aquatic plant production. As a result, most of the selected lakes:

1. were impacted by one or more municipal sewage treatment plants, either directly or by discharge to an inlet tributary within approximately 40 kilometers of the lake;

2. were 40.5 hectares or larger in area; and

3. had mean hydraulic retention times of at least 30 days.

However, these criteria were waived for a number of lakes of particular interest to the states.

In the western states, these criteria were modified to reflect revised water-research mandates, as well as to address more prevelant non-point source problems in agricultural or undeveloped areas. Thus each state was requested to submit a list of candidate lakes for the Survey that:

1. were representative of the full range of water quality (from oligotrophic to eutrophic);

2. were in the recreational, water supply, and/or fish and wildlife propagation use-categories; and

3. were representative of the full scope of nutrient pollution problems or sources (from municipal wastes and/or nutrient-rich industrial discharges, as well as from non-point sources).

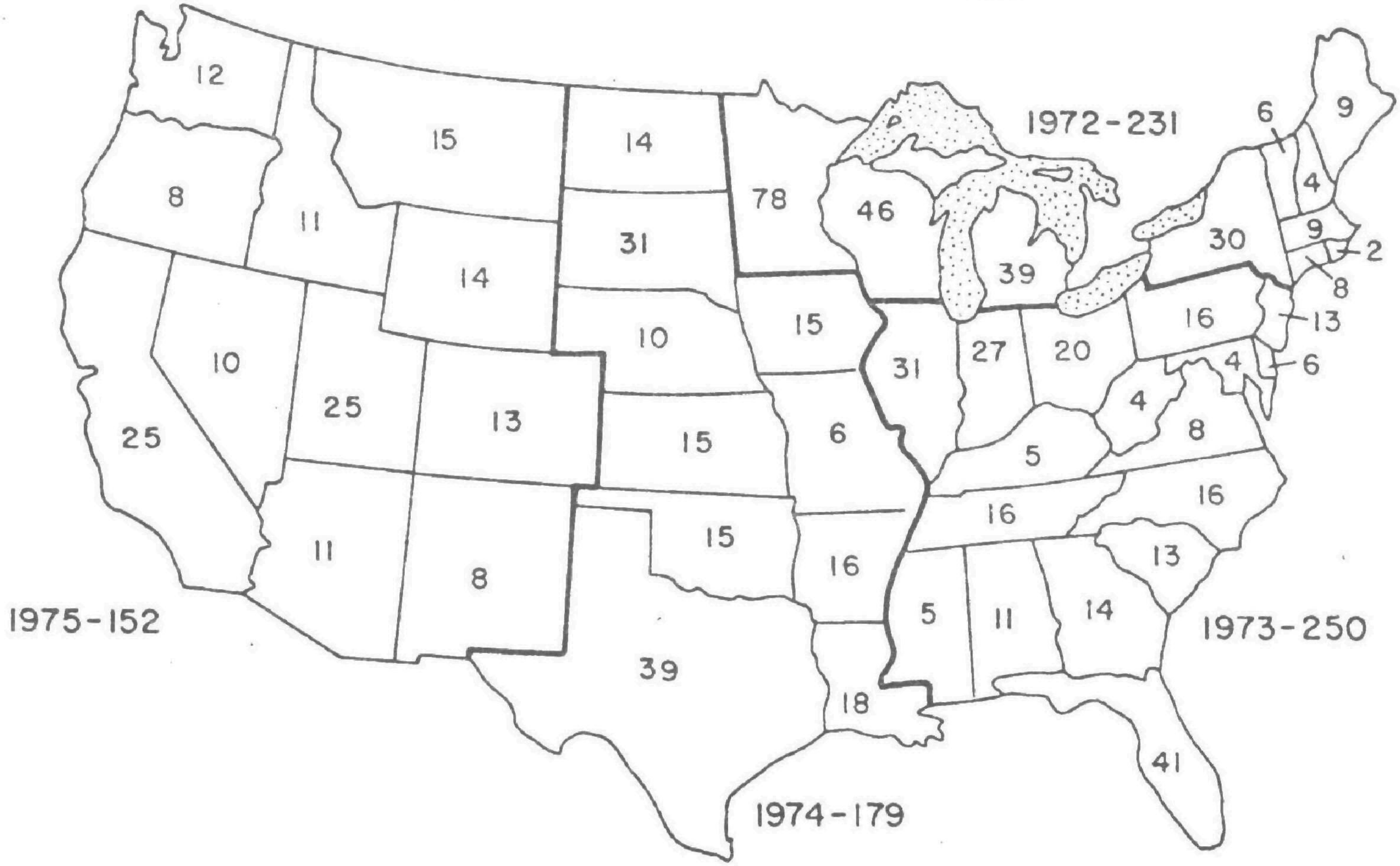
The size and retention time constraints applied in the eastern states were retained as was the waiver provision.

In all cases, listings of potential candidate lakes or reservoirs, prepared with the cooperation of the EPA Regional Offices, were made available to the states to initiate the selection process.

In total, the Survey included 812 lakes and reservoirs across the contiguous 48 United States. The map on the following page shows the distribution of the lakes and reservoirs by state and the year during which the water bodies were sampled.

NATIONAL EUTROPHICATION SURVEY

NUMBER OF LAKES & YEAR SAMPLED



GRAND TOTAL- 812

Several kinds of information are required for management decisions regarding the need for point or non-point source control of phosphorus and perhaps other nutrients as well. The Survey purpose was to collect the type of data which would provide a basis for such decisions or at least to provide a data base which could be supplemented with more detail, if required. First, an annual nutrient budget was estimated for each water body, differentiating between inputs from point and non-point sources; second, the existing trophic condition of the water body was evaluated by sampling; and third, an algal assay was performed to determine whether phosphorus, nitrogen, or some other element was limiting primary productivity of the water body. The methods used to gather this information are described below.

The operations aspects of the Survey were shared by branches of two EPA laboratories and a small Washington, DC headquarters staff. The Environmental Monitoring and Support Laboratory at Las Vegas, Nevada (EMSL-Las Vegas) was responsible for sampling each lake, doing the associated analyses, evaluating a portion of the data, and reporting results. The Corvallis Environmental Research Laboratory (CERL) at Corvallis, Oregon was responsible for coordinating the sampling of streams and sewage treatment plants, analyzing the samples, and performing the algal assay on lake samples. CERL also had the major responsibility for evaluating the lake, stream, and point-source data and incorporating these data into a report on each lake.

The headquarters staff made the initial contact with each state water pollution control agency to explain the function of the Survey and to cooperatively determine which lakes and reservoirs would be included. They also contacted each State National Guard to explain the function of the Survey and to request their assistance in meeting Survey objectives by collecting monthly samples from selected tributaries to surveyed lakes. In addition, the headquarters staff provided general coordination and guidance to the operational aspects of the program.

Because the Survey had to cover a large geographical area in a relatively short period of time, pontoon-equipped UH-1H Bell helicopters with automated and manually-operated instruments were used to measure the water quality of each lake. Two helicopters - carrying a limnologist and a technician - were operated simultaneously, and a third helicopter was used for ferrying parts, equipment, and people. The sampling teams from the EMSL-Las Vegas were supported by a mobile analytical laboratory, chemistry technicians, electronics specialists, and other staff involved with helicopter maintenance or program coordination.

Operating procedures involved establishing a work center at an airport and then sampling all lakes within a 100-mile radius. When all of the water bodies within the area were sampled, the support staff moved to a new central location, and sampling began on a different set of lakes. In this manner, from 150 to 250 lakes were sampled three or more times each year, and the sampling was completed on the 812 lakes in a four-year period.

Listed in the following table are the routine water-quality parameters which were selected to characterize each lake and assess the trophic condition. Parameter selection was based on the relevance of each parameter as a measure of potential and existing primary production. Both the number and the kinds of parameters measured also were limited to a certain extent by the operational aspects of the Survey.

WATER QUALITY CHARACTERISTICS MEASURED

Physical-Chemical

Alkalinity	Nitrogen:
Conductivity	Ammonia
pH	Kjeldahl
Dissolved oxygen	Nitrate-nitrite
Phosphorus:	Secchi depth
Ortho	Temperature
Total	

Biological

Algal assay	Algal count and identification

Chlorophyll *a*

Concurrently with the lake sampling, the significant tributaries and outlet(s) of each lake were sampled monthly, totaling about 4,200 sampling sites nationwide. Volunteer National Guardsmen of each state, trained on-site by EPA or state agency staff, collected and preserved the samples at sites pre-selected by EPA personnel. The samples were shipped to CERL for analysis of the various forms of nitrogen and phosphorus noted in the above table.

Through an interagency agreement, the U.S. Geological Survey estimated flows for each sampled stream. These data were used in conjunction with concentration values to determine nutrient loadings.

A voluntary sampling program was established through the respective state water pollution control agencies to have plant operators collect effluent samples from 1,000 or so municipal sewage treatment plants which impacted Survey lakes. The effluent samples were collected monthly, preserved, and shipped to the Corvallis laboratory for nitrogen and phosphorus analyses.

Specific procedures used in collecting, preserving, shipping, and analyzing the various kinds of samples collected by the Survey are described in National Eutrophication Survey Working Papers (U.S.EPA, 1974-1; 1975-175).

Presently, the sampling phase of the Survey has been completed, tributary sampling ended in November, 1975, the last treatment plant effluent samples were received in January, 1976, and laboratory analyses were finished in February, 1976. The individual lake reports are scheduled for completion by October, 1977.

IV. DATA COMPARISONS

In our effort to relate the Survey findings to information acquired by others, it soon became apparent that a lack of uniformity in data collection and reporting imposes a constraint on comparisons with other data that are available on the water bodies, streams, and point sources sampled by the NES. To be truly comparable, samples should be collected at the same time and place, analyzed by the same methods, etc., unless one is to ignore the expected within-lake, within-stream, within-year, and between-year differences in water quality. Furthermore, even with the most uniform procedures, "... two samples are always different, for the chance of two samples, even though drawn from exactly the same population, being identical in character is practically nil" (Simpson et al., 1960; pg. 172). Indeed, the need for statistical comparisons of data rests on this assumption.

A. In-Lake (Reservoir) Data -

Before comparing the NES lake and reservoir data, we deemed it instructive to examine the variability in lake sampling data. For this purpose, we analyzed data collected and reported in varying ways on seven lakes, most of which differ in geographic, geologic, and morphometric characteristics. The lakes are Geneva, Wisconsin; Minnetonka, Minnesota; four Finger Lakes, New York; and West Okoboji, Iowa. The morphology of these lakes is shown in the following table.

Lake	Area (km^2)	Mean Depth (m)	Maximum Depth (m)	Est. Mean Retention Time (yrs)
Geneva	21.30	18.6	41.1	24
Minnetonka	58.56	6.9	27.8	15
Conesus	12.89	9 (est)	18.9	24
Hemlock	8.37*	14 (est)	-	63
Owasco	27.45	29.3	53.9	26
Skaneateles	35.22*	43.5	-	121
W. Okoboji	15.40	11.9	40.8	20

Some examples of seasonal, between-year, within-year, within-lake, and between-lake differences in data are given in the next five tables where n = number of samples, r = range of values, $\bar{x}$ = the mean, $\bar{\bar{x}}$ = the mean of means, s = standard deviation, and V = Pearson's coefficient of variation in percent (Simpson et al., 1960).

Seasonal differences are shown in the following analyses of data resulting from 8 1/2 years of quarterly near-surface sampling at the same site on Lake Geneva by the Wisconsin Department of Natural Resources (Mason, 1976). The period of record is July, 1968, through November, 1976.

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* Greeson and Robison, 1970

Lake Geneva, Wisconsin

Sampling Period	n	r	$\bar{x}$	s	V(%)
		Soluble Reactive Phosphorus (µg/l)			
Winter	5	0-23	9.4	8.7	93
Spring	7	0-19	10.9	7.3	67
Summer	9	5-17	11.7	5.0	43
Fall	8	7-43	17.1	12.0	70
All data	29	0-43	12.6	8.6	68
		Total Phosphorus (µg/l)			
Winter	6	10-40	25.0	10.5	42
Spring	7	10-40	25.7	9.8	38
Summer	8	20-40	25.0	7.6	30
Fall	8	20-70	40.0	17.7	44
All data	29	10-70	29.3	13.3	45
		Inorganic Nitrogen (µg/l)			
Winter	6	40-410	203.3	151.2	74
Spring	8	100-420	165.0	127.4	77
Summer	5	40-320	162.0	106.4	66
Fall	7	100-190	148.6	36.3	24
All data	26	40-420	168.8	108.0	64
		Total Nitrogen (µg/l)			
Winter	7	440-1,070	625.7	225.7	36
Spring	8	420-930	661.2	170.6	26
Summer	9	360-1,100	653.3	251.9	39
Fall	8	430-820	630.0	156.7	25
All data	32	360-1,100	643.4	233.2	36
		Total Alkalinity (mg/l)			
Winter	7	157-192	179.4	13.1	7
Spring	8	179-188	183.1	2.9	2
Summer	9	162-185	173.0	6.4	4
Fall	7	172-186	179.3	5.7	3
All data	31	157-192	178.5	8.3	5
		Secchi Disc Transparency (m)			
Winter	8	3.2-6.1	4.25	1.13	27
Spring	8	2.7-4.3	3.41	0.59	17
Summer	9	2.4-5.5	3.34	0.95	28
Fall	9	3.0-4.6	3.82	0.52	14
All data	34	2.4-6.1	3.70	0.87	24

Between-year differences are evident in the following analyses of data resulting from nearly three years of near-surface sampling at three- to four-week intervals at the same station on Lake West Okoboji, Iowa (Bachmann and Jones, 1974). The period of record is from 03/10/71 through 09/15/73.

Lake West Okoboji, Iowa; Station 49

Sampling Period	n	r	$\bar{x}$	s	V(%)
Soluble Reactive Phosphorus (μg/l)					
1971	14	0-30	16.4	12.2	74
1972	13	10-40	23.1	11.8	52
1973	18	0-30	14.4	7.8	54
All data	45	0-40	17.6	10.9	62
Total Phosphorus (μg/l)					
1971	3	20-70	50.0	26.5	53
1972	13	20-60	43.8	15.6	36
1973	18	10-40	27.2	7.5	28
All data	34	10-70	35.6	15.6	44
Inorganic Nitrogen (μg/l)					
1971	12	0-640	223.3	219.5	98
1972	13	110-330	201.5	65.3	32
1973	18	20-390	138.9	97.1	70
All data	43	0-640	181.4	138.0	76
Conductivity (μmhos)					
1971	14	326-466	437.6	42.9	10
1972	13	391-454	424.2	17.6	4
1973	18	375-476	437.6	29.8	7
All data	45	326-476	443.7	31.8	7
Secchi Disc Transparency (m)					
1971	10	2.3-4.5	2.95	0.69	23
1972	13	2.6-10.3	5.01	2.44	49
1973	18	2.8-11.7	5.72	2.79	49
All data	41	2.3-11.7	4.82	2.54	53

Within-lake, within-year, and between year differences are shown in the following table. The data resulted from about two years of near-surface sampling at two sites on Lake West Okoboji (Bachmann and Jones, 1974). The samples were collected at comparable times (within three days; usually less) during the period of 03/10/71 through 10/13/72.

Lake West Okoboji, Iowa; Stations 49 and 50

Period and Station	n	r	$\bar{x}$	s	V(%)
		Soluble Reactive Phosphorus (μg/l)			
1971-49	13	0-30	15.4	14.8	96
-50	13	0-30	13.8	9.6	70
1972-49	10	10-40	20.0	11.5	58
-50	10	0-40	16.0	12.6	79
All data-49	23	0-40	27.8	21.0	76
-50	23	0-40	14.8	10.8	73
		Total Phosphorus (μg/l)			
1971-49	2	20-70	-	-	-
-50	2	30-30	-	-	-
1972-49	10	20-60	44.0	16.5	38
-50	10	20-70	36.0	17.1	48
All data-49	12	20-70	44.2	18.3	41
-50	12	20-70	35.0	15.7	45
		Inorganic Nitrogen (μg/l)			
1971-49	11	0-640	216.4	228.8	106
-50	11	0-550	182.7	214.5	117
1972-49	10	110-260	177.0	49.0	28
-50	10	30-360	167.0	103.9	62
All data-49	21	0-640	197.6	166.3	84
-50	21	0-550	175.2	167.1	95
		Conductivity (μmhos)			
1971-49	13	326-466	438.9	35.4	8
-50	13	427-476	445.9	15.1	3
1972-49	10	406-454	427.8	15.7	4
-50	10	410-471	428.1	17.6	4
All data-49	23	326-466	434.1	28.6	7
-50	23	410-476	438.2	18.2	4

(Continued)

West Lake Okoboji, Iowa; Stations 49 and 50

Period and Station	n	r	$\bar{x}$	s	V(%)
		Secchi Disc Transparency (m)			
1971-49	9	2.3-4.5	2.87	0.67	23
-50	9	1.6-4.0	2.41	0.71	29
1972-49	10	2.6-7.3	4.40	1.70	39
-50	10	2.3-6.0	3.87	1.32	34
All data-49	19	2.3-7.3	3.67	1.50	41
-50	19	1.6-6.0	3.18	1.29	41

Another example of within-lake and within-year differences is given in the next table which is based on the data resulting from near-surface sampling on the same days at three sites on lower Lake Minnetonka (Megard, 1970). The sites were Megard's Gale Island (GI), Browns Bay (BB), and Wayzata Bay (WB) sampling stations, and the sampling period was from April through October 1969.

Lake Minnetonka, Minnesota

Station	n	r	$\bar{x}$	s	V(%)
		Soluble Reactive Phosphorus (μg/l)			
GI	6	7-10	8.2	1.2	15
BB	6	6-45	16.3	15.8	97
WB	6	3-8	6.3	2.0	32
		Total Phosphorus (μg/l)			
GI	7	36-66	49.9	11.9	24
BB	7	39-80	54.9	17.4	32
WB	7	35-72	47.6	13.5	28
		Inorganic Nitrogen (μg/l)			
GI	7	86-651	294.6	200.2	68
BB	6	178-857	390.7	245.9	63
WB	7	85-1,147	341.3	367.4	108
		Chlorophyll (μg/l)			
GI	6	14-40	24.7	9.4	38
BB	7	8-43	20.9	12.6	60
WB	7	8-38	20.6	11.9	58

Finally, between-lake differences are evident in the data on four of the Finger Lakes of New York reported by Oglesby (1972). The Finger Lakes are of similar type (type 30b; Hutchinson, 1957, pg. 86) and, chemically, "....the two westernmost lakes, Conesus and Hemlock, are similar to one another as are the three more eastern ones, Cayuga, Owasco and Skaneateles..." (Oglesby, op. cit., pg. 5). The analyses shown are based on the means of epilimnetic values for all sampling stations at each of the lakes from 07/06/71 through 11/03/71; i.e., the analyses are on populations of means. Had the raw values been used, the variation almost certainly would have been greater than shown (e.g., using the Lake Geneva seasonal means of soluble reactive phosphorus instead of the raw values would have resulted in V = 28 for "all data" rather than V = 68 as shown above).

Finger Lakes, New York

Lake	n	r	$\bar{\bar{x}}$	s	V(%)
		Soluble Reactive Phosphorus (μg/l)			
Conesus	8	2.8-40.8	21.4	12.8	60
Hemlock	9	0.6-49.3	12.3	15.6	127
Owasco	10	4.1-27.0	12.2	7.8	64
Skaneateles	6	0.4-16.7	7.7	6.1	79
		Nitrate-N (μg/l)			
Conesus	9	2-28	11.8	9.4	80
Hemlock	9	0-97	25.2	34.8	138
Owasco	9	71-281	171.8	64.7	38
Skaneateles	6	86-230	125.2	55.1	44
		Chlorophyll a (μg/l)			
Conesus	8	2.08-21.78	6.75	6.55	97
Hemlock	7	2.6-18.3	6.6	5.3	80
Owasco	10	2.26-9.53	5.10	2.72	53
Skaneateles	4	1.38-3.55	2.34	1.04	44

The clear message of the above analyses is that variability in lake data is to be expected, particularly in nitrogen and phosphorus data. Note that the more-conservative parameters, alkalinity and conductivity, show much less variation.

To minimize the expected variation and permit valid comparisons, only data obtained by others on the same water bodies sampled by the NES and, to the degree possible, at the same or similar sampling sites, depths, dates, and years have been used to test the validity of the NES data.

First, prior to the Ecology Advisory Committee visit to CERL, Mason (1976) made a comparison of the NES data and Wisconsin Department of Natural Resources data on "six well-known and well-sampled Wisconsin lakes" (Mason, op. cit.) ranging in quality from oligotrophic Crystal Lake to hypereutrophic Lake Delevan. Although Mason's comparison included data from other depths, for brevity only the mean near-surface values are shown below; the numbers of samples are in parentheses.

Agency-Year	Secchi Disc (m)	Total Alkalinity (mg/l)	Conductivity (µmhos)	$NO_2 + NO_3 - N$ (µg/l)	$NH_3 - N$ (µg/l)	Total Phosphorus (µg/l)
			Big Green*			
DNR-1966	5.5 (7)	-	-	200 (10)	50 (10)	40 (17)
-1971-73	7.3 (19)	176 (18)	421 (16)	90 (18)	<30 (18)	50 (10)
NES-1972	6.4 (3)	170 (3)	377 (3)	80 (3)	30 (3)	30 (3)
			Crystal*			
DNR-1966	7.9 (8)	-	-	70 (11)	50 (11)	30 (11)
-1971-73	7.9 (6)	4 (6)	17 (6)	30 (6)	100 (6)	20 (6)
NES-1972	7.9 (3)	<10 (3)	<50 (3)	30 (3)	40 (3)	6 (3)
			Delevan*			
DNR-1966	1.5 (9)	-	-	240 (11)	230 (11)	170 (11)
-1971-73	3.4 (11)	177 (19)	484 (16)	200 (17)	250 (19)	140 (19)
NES-1972	1.5 (3)	163 (3)	438 (3)	110 (3)	310 (3)	120 (3)
			Geneva*			
DNR-1966	4.6 (9)	-	-	200 (10)	50 (10)	40 (10)
-1971-73	3.7 (19)	178 (18)	396 (17)	60 (17)	60 (19)	40 (19)
NES-1972	3.4 (3)	176 (3)	375 (3)	40 (3)	30 (3)	13 (3)
			Trout*			
DNR-1966	4.0 (7)	-	-	90 (10)	40 (10)	50 (10)
-1971-73	4.6 (10)	42 (10)	100 (8)	80 (10)	<30 (10)	20 (10)
NES-1972	4.6 (3)	39 (3)	94 (3)	30 (3)	40 (3)	10 (3)
			Winnebago*			
DNR-1966	0.7 (7)	-	-	270 (10)	90 (10)	130 (10)
-1971-73	1.2 (17)	146 (17)	335 (14)	290 (18)	140 (18)	150 (18)
NES-1972	0.7 (3)	138 (3)	301 (3)	130 (3)	110 (3)	100 (3)

*Respectively, Working Papers No. 39, 66, 36, 61, 71, and 57

In his independent assessment, Mason concluded that "the most significant point is that when you consider the surveys were carried out independently and by different methods - different people, different sampling techniques, and, most importantly, different laboratories - the data... compare remarkably well. There are some minor differences, of course, but...EPA should be able to classify the lakes they have sampled fairly accurately even with their limited amount of data".

Another comparison of NES data and the Wisconsin Department of Natural Resources (DNR) data provided by Mason is tabulated below. The results are from sampling Big Green Lake in 1972 at the same site and on dates and at depths as comparable as is possible.

Agency-Date	Depth (m)	Total P (μg/l)	Inorganic N (μg/l)	pH (units)	Total Alk. (mg/l)	Conductivity (μmhos)	Secchi Disc (m)
DNR-04/27	near-surface	30	123	8.2	176	329	7.3
NES-06/22	near-surface	29	70	8.8	173	345	5.6
DNR	21.3	40	133	8.2	177	358	-
NES	18.9	50	230	8.2	179	350	-
DNR-07/18	near-surface	40	<90	8.8	177	400	5.8
NES-08/21	near-surface	11	70	8.5	169	370	6.1
DNR	21.3	50	210	8.0	179	300	-
NES	24.4	53	330	7.9	178	390	-
DNR	44.2	70	250	8.0	179	275	-
NES	45.7	78	400	7.8	176	390	-
DNR	67.0	260	677	7.8	180	280	-
NES	62.5	249	580	7.5	182	395	-
DNR-11/21	near-surface	30	280	8.3	174	365	7.6
NES-11/08	near-surface	28	210	8.3	169	415	7.6
DNR	21.3	40	300	8.2	180	370	-
NES	22.9	34	230	8.2	180	410	-
DNR	44.2	70	350	8.1	182	360	-
NES	45.7	83	350	7.7	183	410	-
DNR	67.0	190	370	8.2	192	379	-
NES	60.3	109	410	7.6	184	410	-

The results of the statistical analyses of these data are shown below where n, $\bar{x}$, s, and V are as previously defined, C is Spearman's coefficient of rank correlation, and t = Student's two-tailed t-test for the difference between paired samples (Simpson et al., 1960). Note, however, that pH values are logarithms of the reciprocal of the normality of free hydrogen ions (Welch, 1952); and, except for C, statistical analyses of the pH units per se are incorrect mathematically (Barth, 1975). Therefore, the pH units were converted to the respective hydrogen ion concentrations in moles/l, and the statistical analyses were made using those numbers. The means and the standard deviation were then converted back to pH units (note that -s does not equal +s because the values shown are logarithms; in terms of concentrations [moles/l], the NES $\bar{x}$ is 1.2751×10^{-8}, and s is $\pm 1.0166 \times 10^{-8}$; the DNR $\bar{x}$ is 7.5628×10^{-9}, and s is $\pm 3.7890 \times 10^{-9}$). Since the t and V values are ratios, they have not been converted to logarithms.

Agency	n	$\bar{x}$	s	V(%)	C	t
		Total Phosphorus				
DNR	10	82.0	78.4	96	0.92	1.090
NES	10	72.4	68.8	95		
		Inorganic Nitrogen				
DNR	10	278.3	133.7	48	0.81	0.386
NES	10	289.0	159.0	55		
		pH				
DNR	10	8.12	-0.18,+0.30	50	0.71	0.676
NES	10	7.89	-0.25,+0.70	80		
		Total Alkalinity				
DNR	10	179.6	4.9	3	0.91	1.746
NES	10	177.3	5.5	3		
		Conductivity				
DNR	10	341.6	43.3	13	0.32	3.046
NES	10	388.5	35.5	7		
		Secchi Disc				
DNR	3	6.90	0.96	14	0.50	1.204
NES	3	6.43	1.04	16		

Except for conductivity, the t-tests indicate none of the differences between means are significant at the 5% probability level, and the coefficients of rank correlation indicate the DNR and NES data compare quite well (the relatively low C value for Secchi disc probably results from differences in sampling times of as much as two months).

The null hypothesis of no difference between the conductivity means is rejected at the 5% probability level. The reason for the difference in the conductivity measurements is not known but could have been the result of differing temperature compensation/correction. It will be noted the NES values were higher than DNR's in eight of the ten pairs.

Below, 1972 NES total phosphorus data (in µg/l) are compared to unpublished EPA Shagawa Lake Project data from two sampling sites at similar but not identical depths on similar but not the same sampling days. NES stations 1 and 2 correspond to Project stations B and E, respectively, and the depths sampled range from near-surface to a maximum of 12.1 meters (usually to about 9 meters). The statistical symbols shown have been defined previously.

	Station & Date			Station & Date		
	B 07/05	#1 07/08	B 07/11	E 07/05	#2 07/08	E 07/11
	24	33	24	30	34	32
	30	29	25	31	34	28
	59	38	49	42	192	39
	174	164	271	78	214	143
	287	381	425	587	390	737
$\bar{x}$=	114.8	129.0	158.8	153.6	172.8	195.8
s=	113.7	151.8	181.4	243.1	148.1	306.3
V=	99	118	114	158	86	156

	B 09/05	#1 09/07	B 09/12	E 09/05	#2 09/07	E 09/12
	102	64	89	78	65	90
	97	66	90	81	61	96
	93	87	84	76	60	87
	83	87	87	89	69	80
	93	102	81	330	303	145
$\bar{x}$=	93.6	81.2	86.2	130.8	111.6	99.6
s=	7.0	16.0	3.7	111.5	107.1	26.0
V=	7	20	4	85	96	26

	B 10/16	#1 10/22	B 10/24	E 10/17	#2 10/22	E 10/24
	68	35	47	50	40	52
	86	50	74	61	47	83
	53	40	49	56	48	55
	59	41	48	53	37	53
	55	38	51	53	37	51
$\bar{x}$=	64.2	40.8	53.8	54.6	41.8	58.8
s=	13.5	5.6	11.4	4.2	5.4	13.6
V=	21	14	21	8	13	23

The above comparisons show good agreement between the NES data and the Project data for both stations and sampling days in July and for both sampling days at Project station E in September. However, an inverse relationship is apparent in the September NES station 1 and Project station B data; and in October, NES values are lower than Project values at both stations and sampling days.

The distribution-free Kruskal-Wallis H test (Downie and Heath, 1970) was used to test whether the three sets of samples were from the same or different populations. The results indicate a significant difference at the 5% level at both Project stations in October but not at either station in July or September. Student's t-tests were then computed to determine the significance of differences in means, and the null hypotheses of no difference are rejected at the 5% level for the means of NES station 1 October data and Project station B October 16 data as well as the means of NES station 2 October data and Project station E October 17 and 24 data.

Coefficients of rank correlation show good agreement between NES and Project data in July, fairly good agreement between NES station 2 and Project station E data in September and October, and also the inverse relationship noted above between NES station 1 and Project station B data in September (negative C values). Overall, the coefficients indicate the correlation between NES data sets and Project data sets is about as good as the correlation between comparable Project data sets.

The results of the statistical analyses are tabulated on the next page.

Stations and Dates	H	C	t
B-7/5; #1-7/8; B-7/11	0.015	-	-
B-7/5; B-7/11	-	1.00	0.460
B-7/5; #1-7/8	-	0.90	0.167
B-7/11; #1-7/8	-	0.90	0.282
E-7/5; #2-7/8; E-7/11	0.560	-	-
E-7/5; E-7/11	-	0.90	0.241
E-7/5; #2-7/8	-	0.98	0.151
E-7/11; #2-7/8	-	0.98	0.151
B-9/5; #1-9/7; B-9/12	3.185	-	-
B-9/5; B-9/12	-	0.58	2.093
B-9/5; #1-9/7	-	-0.68	1.586
B-9/12; #1-9/7	-	-0.82	0.680
E-9/5; #2-9/7; E-9/12	4.160	-	-
E-9/5; E-9/12	-	0.40	0.609
E-9/5; #2-9/7	-	0.90	0.278
E-9/12; #2-9/7	-	0.30	0.244
B-10/16; #1-10/22; B-10/24	9.400	-	-
B-10/16; B-10/24	-	0.10	1.256
B-10/16; #1-10/22	-	0.30	3.582
B-10/24; #1-10/22	-	0.55	2.287
E-10/17; #2-10/22; E-10/24	9.380	-	-
E-10/17; E-10/24	-	0.82	0.660
E-10/17; #2-10/22	-	0.60	4.220
E-10/24; #2-10/22	-	0.72	2.599

While the cause(s) of the partial differences between NES and Project data cannot be identified with certainty, there are at least two possibilities: (1) sampling methods and (2) sample analyses.

Project samples were collected by means of Van Dorn samplers ranging in size from 4-liter capacity (45 by 10 cm) to 8-liter capacity (78 by 13 cm). Typically, the midpoint of the sampler was positioned as nearly at the desired depth as wind and wave would permit, and a vertical column of water of from nearly 1/2 meter to 3/4 meter in height (depending on the size of the sampler used) was removed as the sample. Survey sampling, on the other hand, was by means of a submersible pump with the intake positioned at the selected depth (again varying somewhat depending on wave conditions). While there is no way of knowing what distances radially from the pump intake water was drawn, the maximum rate of the pump used in 1972 was only about 7 liters per minute, and it seems likely that the Survey samples were from more-limited strata than the Project samples. Also, as noted previously, NES and Project samples were not from exactly the same depths; there were differences as great as 0.8 meters, and Project data show as much as 485 μg/l change in total phosphorus with an increase of 1.5-meters in depth (9 to 10.5-meters at station B on 09/05/72).

While sampling methods may have resulted in some differences, the consistently lower NES concentrations in October probably were due in some part to differences in analyses since Shagawa Lake was homothermous and relatively well-mixed at that time.

In early 1973, sets of analytical quality control replicate samples were prepared at CERL and were sent to EMSL-LV and the Project laboratory at Ely for analyses of nitrogen and phosphorus species. The results of this round-robin testing for total phosphorus are shown in the following table.

Total Phosphate Phosphorus (mg/l)

Sample #	Corvallis	Ely	Las Vegas
1	0.145	0.194	0.169
2	0.15	0.176	0.156
3	0.16	0.183	0.163
4	0.15	0.187	0.153
5	0.16	0.19 (u)*	0.163
$\bar{x}$=	0.153	0.185	0.161
s=	0.007	0.008	0.006

* Unreliable; not used in calculations

It will be noted that the mean of the Ely values for this series is 15% higher than the mean of the Las Vegas (EMSL) values. From this it cannot be said the analyses of one laboratory are better than those of the other, since the true value of total phosphorus in the sample from which the aliquots were drawn (a composite of tributary samples) is not known. However, if similar differences occurred in the analyses of the October Shagawa Lake samples, that would account for a major portion of the apparent differences between NES and Project data.

In the interests of brevity and conservation of typing effort, generally in succeeding comparisons only the pertinent data will be given. Statistical analyses will be shown only where necessary for a better understanding of the significance of differences between NES data and data collected by others.

At Big Spirit Lake, Iowa, Bachmann and Jones (1974) collected only near-surface samples on September 15, 1973 at three stations corresponding to NES stations sampled on September 23, 1974:

Agency & Station	Sol. Reactive P (μg/l)	Total P (μg/l)	Dissolved Oxygen (mg/l)	Secchi disc (m)
B&J-54.4	10	40	9.5	1.2
NES-1	6	38	9.0	1.4
B&J-54.0	10	40	9.1	1.4
NES-2	13	58	9.2	1.1
B&J-54.1	0	30	9.3	1.4
NES-3	7	40	9.4	1.2

On the same date (09/15/73), they collected samples to 35 meters in depth at one station on Lake West Okoboji corresponding to a NES station sampled to 39 meters in depth on 09/23/74. In the following table, only data from comparable depths are shown.

Agency	Depth	Sol. Reactive P (μg/l)	Total P (μg/l)	Dissolved Oxygen (mg/l)	Secchi disc (m)
B&J	near-	10	30	7.2	2.8
NES	surface	24	46	8.0	2.6
B&J	mid-	10	33	6.9	-
NES	depth	26	54	7.9	-
B&J	near-	245	250	1.2	-
NES	bottom	146	270	2.6	-

Total phosphorus data obtained by Megard (1970) at eight stations on Lake Minnetonka in June, September, and October, 1969 were compared to NES data obtained at the same stations in June, September, and October, 1972. The means of all of the water column values at similar depths were calculated. The mean of Megard's data is 58.9 μg/l, and the mean of NES data is 53.1 μg/l. The null hypothesis of no difference between the means is accepted at the 60% probability level (t=0.507; degrees of freedom [d.f.]=44).

Nutrient data for a number of TVA reservoirs reported by Brye (1970) were obtained in various years ranging from 1963-64 (Guntersville Reservoir, AL) to 1968-69 (Nottely Reservoir, GA); the NES data were obtained in 1973. The data compared are the means of all water column values for corresponding TVA and NES sampling stations and depths, except for Douglas and Nottely reservoirs (means of epilimnetic values). Overall, the data are quite comparable, particularly when the differences in sampling times are considered.

Reservoir	Agency & Station	Total P (µg/l)	Total N (µg/l)
Douglas, TN	TVA-54.0	39	680
	NES-2	27	594
	TVA-43.0	25	700
	NES-3	22	625
	TVA-33.0	24	640
	NES-6	20	681
Nottely, GA	TVA-21.1	17	390
	NES-1	14	397
	TVA-27.5	16	340
	NES-3	17	341
Guntersville, AL	TVA-358.0	47	240
	NES-2	47	786
	TVA-369.7	49	220
	NES-4	43	844
	TVA-385.9	46	290
	NES-8	47	826
Wilson, AL	TVA-259.7	46	670
	NES-1	46	625
	TVA-265.0	67	902
	NES-2	42	624
	TVA-273.5	41	620
	NES-3	63	647
Pickwick, AL	TVA-207.6	77	710
	NES-1	57	734
	TVA-220.0	101	890
	NES-3	59	674
	TVA-245.0	78	840
	NES-6	57	750
Kentucky, KY, TN, & MS	TVA-23.0	70	870
	NES-1	78	738
	TVA-42.0	74	910
	NES-3	85	640
	TVA-66.0	90	920
	NES-6	76	780
	TVA-91.0	139	770
	NES-10	62	778
	TVA-112.0	79	530
	NES-17	56	682

Limited water quality data obtained at Lake Norman, NC, by the Duke Power Company (DPC) were provided by Bowling (1976). The Company data are from 08/27/73 and 09/24/73 sampling at three stations corresponding to three NES stations that were sampled on 07/17/73 and 09/19/73. The values shown are means of values at comparable sampling depths.

Agency & Station	Depth	Sol.Reactive P (µg/l)	Total P (µg/l)	Alkalinity (µg/l)
	near-surface	7	16	14
		8	13	20
DPC-1	mid-depth	5	18	20
NES-1		4	8	19
	near-bottom	7	25	21
		3	12	22
	near-surface	5	12	19
		6	12	17
DPC-11	mid-depth	5	14	19
NES-3		3	10	20
	near-bottom	5	56	18
		4	12	18
	near-surface	5	14	13
		5	15	17
DPC-13	mid-depth	6	15	22
NES-4		6	15	18
	near-bottom	5	37	18
		5	21	18

The above data compare very well except for the DPC near-bottom total phosphorus values which were consistently higher than NES values.

Water quality data for Lake Wylie, NC, were reported by Gerhold (1975). His data obtained in April and July, 1974, are compared to NES data obtained at the same station (NES-4) in April and July, 1973.

Data Source	Sol. Reactive P (µg/l)	Total P (µg/l)	Total N (µg/l)	Alkalinity (mg/l)
G-04/74	3	42	483	9
NES-04/73	6	45	490	11
G-07/74	4	31	469	11
NES-07/73	3	20	480	18

Collings (1973) reported U.S. Geological Survey water quality data for a number of lakes in the State of Washington, including American Lake which was sampled by the NES in 1975. The U.S.G.S. data were obtained in 1969 and 1970 at "north end" and "south end" of the lake stations that are assumed to correspond to NES stations 3 and 1, respectively. The data compared are from as similar depths as possible in October, 1970, and October, 1975.

Data Source	Depth (m)	Sol.Reactive P (μg/1)	Total P (μg/1)	Total N (μg/1)	Alkalinity (mg/1)
C-North	0.9	6	13	180	41
NES-3	1.5	2	21	220	41
C-North	13.4	6	10	130	42
NES-3	15.2	76	100	620	45
C-North	26.5	160	200	1800	42
NES-3	23.5	167	306	2120	45
C-South	0.9	6	6	300	41
NES-1	1.5	31	70	320	43
C-South	13.4	6	10	180	43
NES-1	7.3	27	86	520	42

Except for alkalinity and the nutrient values for the deepest samples at NES station 3, the above data do not compare too well. The general lack of agreement is not surprising in view of the uncertainty as to the location of the U.S.G.S. sampling stations and the lapse of five years between the two sampling efforts.

Recently, Welch (1977) reported the effects of nutrient diversion on Lake Sammamish, Washington. Some of the 1975 water quality data resulting from that study were provided by Welch (personal communication) and are compared to 1975 NES data from the same sampling station at times and depths as similar as possible:

Source & Date	Depth (m)	Sol. Reactive P (μg/1)	Total P (μg/1)	Diss. Oxygen (mg/1)	Secchi Disc (m)
W-03/27	near-	2	16	12.8	2.5
NES-03/31	surface	-	25	13.2	2.6
W	1.0	2	16	12.9	
NES	1.5	-	21	13.0	
W	5.0	2	15	12.9	
NES	6.1	3	39	13.0	
W	10.0	2	16	12.8	
NES	12.2	3	29	12.6	
W	20.0	2	14	12.6	
NES	18.2	4	35	12.6	
W	25.0	2	-	12.6	
NES	24.4	4	90	12.4	

(Continued)

Source & Date	Depth (m)	Sol. Reactive P (µg/l)	Total P (µg/l)	Diss. Oxygen (mg/l)	Secchi Disc (m)
W-07/31	near-	5	12	11.6	3.0
NES-07/17	surface	5	13	10.6	3.7
W	1.0	5	16	11.4	
NES	1.5	5	11	10.8	
W	5.0	8	14	11.5	
NES	4.6	11	13	10.6	
W	10.0	1	7	10.9	
NES	9.1	12	12	10.8	
W	15.0	2	14	7.0	
NES	15.2	12	12	8.2	
W	20.0	4	17	3.8	
NES	21.3	17	18	2.4	
W-11/11	near-	5	18	10.3	2.5
NES-10/28	surface	5	17	9.0	3.7
W	1.0	4	18	10.6	
NES	1.5	4	15	9.2	
W	5.0	5	17	10.7	
NES	5.5	9	19	7.8	
W	15.0	4	22	10.6	
NES	16.8	7	22	-	
W	20.0	4	22	10.6	
NES	22.9	3	15	6.8	

Except for March total phosphorus and July soluble reactive phosphorus, the data compare very well. The NES March total P values are consistently greater than Welch's values, and the null hypothesis of no difference between the means is rejected at the 5% probability level ($t = 4.382$ with 8 d. f.). However, Lake Sammamish was homothermous and well-mixed at that time (note the uniform dissolved oxygen values), and changes in non-conservative parameters would not be unexpected. For example, the null hypothesis of no difference between the means of total P values obtained by Welch on March 11 and 27 at identical depths is also rejected at the 5% probability level ($t = 4.999$ with 16 d. f.).

The reason for the difference in July soluble reactive P is not known, but it will be noted that the differences occurred at the 10, 15, and 20 meter depths where NES data indicate all of the phosphorus was soluble (i.e., SP = TP). Also, at two greater depths not sampled by NES (25 and 27 meters), Welch's SP values increased to 12 µg/l, but his TP values increased proportionately as well.

Finally, limited data for Oregon's ultra-oligotrophic Waldo Lake (Malueg et al., 1972) and meso-eutrophic Diamond Lake are shown below. The NES 1975 data are compared to unpublished 1975 data obtained in a continuing program of monitoring the two lakes by the Marine and Freshwater Ecology Branch of CERL. Sampling times and depths are as similar as possible; however, at both lakes, the NES sampling station was at least 0.8 km removed from the comparable CERL station.

The Waldo Lake data were obtained on 09/04/75 by CERL and on 10/31/75 by NES:

Agency	Depth (m)	Sol. Reactive P (μg/l)	Total P (μg/l)	Total N (μg/l)
CERL	near-	<5	<10	< 80
NES	surface	3	6	<220
CERL	20.0	<5	<10	55
NES	15.2	2	4	<220
CERL	40.0	<5	10	55
NES	41.1	2	5	<220
CERL	60.0	<5	<10	-
NES	53.3	<2	4	<220

About all that can be said about the above data is that they indicate the problem of analysis of very low levels of nutrients.

The Diamond Lake data were obtained by CERL on 07/10/75 and by NES on 07/16/75:

Agency	Depth (m)	Total P (μg/l)	Total N (μg/l)
CERL	near-	20	355
NES	surface	11	220
CERL	5.0	28	305
NES	4.6	11	220
CERL	10.0	35	355
NES	9.1	45	320

The NES and CERL data on Diamond Lake do not compare too well, except for the 10-meter level. How much of the difference is real and how much is due to the distance between the two sampling stations is uncertain. However, the results of NES sampling at the same time at a second station somewhat further removed from the CERL station are very similar to the CERL values; i.e., total P ranging from 30 to 37 μg/l and total N of 400+ μg/l (NO_2 + NO_3 = <20 μg/l).

B. Trophic Condition -

1. Assessment -

A part of the evaluation of the water bodies sampled by the NES included an assessment of trophic condition based on Survey data and the data of others and categorization in terms of the classical descriptors, oligo-, meso-, and eutrophic.

While there is general agreement in the scientific community as to the fundamental concepts of trophic condition, recently reviewed by Hutchinson (1973), there is some divergence in interpretation of the relative significance of parameters commonly used in a trophic assessment (e.g., nutrients, dissolved oxygen, chlorophyll, plankton kinds and numbers, transparency, benthic organisms, fish species and abundance, etc.), possibly because many of the physical, chemical, and biological relationships in aquatic ecosystems are not well-understood. Because of this, assessments provided by aquatic scientists are to a degree subjective, and the designations of trophic condition made by one worker may not be wholly acceptable to all others.

Among the parameters measured by the NES, trophic assessment primarily and consistently was based on the following generally accepted indicators of trophic condition:

Parameter	Condition		
	Oligotrophic	Mesotrophic	Eutrophic
Total Phosphorus (μg/l)	<10	10-20	>20-25
Chlorophyll *a* (μg/l)	< 4	4-10	> 10
Secchi depth (meters)	> 3.7	2.0-3.7	< 2.0
Hypolimnetic Dissolved Oxygen (% saturation)	>80	10-80	< 10

In addition to the above criteria, the phytoplankton were evaluated.

The rationale for the parameter limits in the above table is as follows:

Total phosphorus - the 10 μg/l limit was first suggested by Sawyer (1947) and was adopted by Vollenweider (1968) as an "oligotrophic" level with a "eutrophic" level of twice that. The Vollenweider limits have since been adopted by others; i.e., Dillon (1975) and Larsen and Mercier (1976).

Chlorophyll _a_ - The limits are those recommended by the Environmental Studies Board of the National Academies of Science and Engineering (1972).

Secchi depth - the oligotrophic limit is based on the mean value for Wisconsin lakes in which there was no deterioration of recreational potential due to plankton growths (Lueschow et al., 1970). The eutrophic limit approximates that proposed as a minimum for primary contact recreation (1.2 m) by the National Technical Advisory Committee (1968).

Dissolved oxygen (DO) - the saturation limits may be somewhat arbitrary but are based on the generally accepted premises of an orthograde DO curve with little or no depression with depth in oligotrophic lakes, a clinograde DO curve in mesotrophic lakes with some depression with depth, and a clinograde DO curve in eutrophic lakes with marked depression or depletion with depth.

The evaluation of phytoplankton primarily involved numbers, kinds, and associations (Hutchinson, 1967), although some indices were utilized with caution; i.e., Nygaard's indices (Nygaard, 1949), Palmer's organic pollution indices (Palmer, 1969), and a species diversity and abundance index (Shannon and Weaver, 1963).

Other than the 500 organisms per milliliter proposed by Lackey (1945), which we judged to be too restrictive, we could not find a quantitative definition of a phytoplankton "bloom" in the literature, and the following criteria were more or less arbitrarily adopted (disregarding spring diatom pulses):

<u>Oligotrophy</u> - less than 1000/ml; filamentous blue-green algae essentially absent in all samples.

<u>Mesotrophy</u> - less than 5000/ml; filamentous blue-green algae, if present, not dominant in any sample.

<u>Eutrophy</u> - more than 5000/ml with filamentous blue-green algae common but not necessarily dominant; <u>or</u>, 1000 or more/ml with filamentous blue-green algae dominant in most or all samples.

In the application of the five physical, chemical, and biological limits discussed above, it was not unusual to find a lake meeting, say, one criterion for oligotrophy, three criteria for mesotrophy, and one criterion for eutrophy (such a lake would be categorized as mesotrophic), or meeting two criteria for oligotrophy and three for mesotrophy (categorized as oligo-mesotrophic), or meeting two criteria for mesotrophy and three for eutrophy (categorized as meso-eutrophic). However, those water bodies classified as oligotrophic met all five of the criteria for oligotrophy.

Also, in many large reservoirs, it was found that the major tributary embayments (nearest the nutrient sources) are eutrophic while the main body of the impoundment is mesotrophic (or even oligotrophic in the case of Garrison Reservoir, ND). Similarly, spatial differences in trophic condition were evident in a few large lakes such as Champlain, NY and VT; Winnipesaukee, NH; and, particularly, in Memphremagog, VT and Quebec, in which the south (U.S.) end is eutrophic and the north (Canada) end is oligotrophic.

Our assessment of oligo- and mesotrophic conditions on the basis of the key parameters seldom involved significant differences of opinion with others; however, most of the water bodies included in the NES are eutrophic because (1) initially selection primarily was based on municipal point-source impact and (2) later, when the selection criteria were changed, many of the water bodies were in areas of high natural fertility as in the corn belt and many of the western states. Not only because of the preponderance of eutrophic water bodies among those sampled by the NES, but also because the term "eutrophic" encompasses a broad continuum of trophic conditions ranging from relatively good to very poor, more disagreement resulted from our assessment of this condition. Indeed, in some geographic areas, most of the water bodies sampled are eutrophic, but there is local resistance to calling them that because of a supposed implication of poor management of those waters.

2. Trophic Index -

Early in the NES, it became apparent that a ranking system would be useful in assessing the trophic condition of the water bodies studied, as well as provide the users of NES reports a measure of the relative quality of a particular water body within the diverse group categorized as "eutrophic". Therefore, a percentile trophic index was devised (the development, utility, and shortcomings of the index are discussed in Working Paper No. 24 [U.S.EPA, 1974-24]).

While there appear to be drawbacks to any trophic ranking system, most likely because of an insufficiency of comparable data (Hooper, 1969), the concept appeals to those who feel the classical terminology is too inflexible, and indices have been proposed recently by Carlson (1977), Harkins (1974), and Uttormark and Wall (1975). Carlson proposes a single-parameter index, Harkins uses multivariate analysis, and the Uttormark and Wall index is largely based on subjective information obtained by questionnaires.

The NES index has been compared with the Carlson index and the Harkins index using data on 39 south-central water bodies. Spearman's coefficient of rank correlation (Simpson et al., 1960) was calculated between the NES and Harkins rankings, between the NES and Carlson rankings, and between the Harkins and Carlson rankings in two-by-two pairs. The coefficient of correlation between the NES and Harkins is 0.97, between the NES and Carlson is 0.86, and between Harkins and Carlson is 0.82.

These rather high correlation values suggest that there is a high degree of association among the three methods, that the rank order is very similar whichever index is used, and that the NES relative trophic index compares very well with the other two indices.

C. Limiting Nutrient -

"It is generally considered reasonable to start any investigation by assuming what is usually called Liebig's Law of the Minimum holds at least approximately" (Hutchinson, 1973, pg. 274). Phosphorus and nitrogen have long been recognized as limiting elements in aquatic ecosystems (Sawyer, 1947; Deevey, 1972).

In the NES assessment of limiting nutrient, only phosphorus and nitrogen were evaluated, although it was recognized a priori that other elements can be limiting (Goldman, 1972) as well as such physical variables as light, temperature, and mixing of the water mass. The determination was made by two methods - nutrient-spiked algal assays and the in-lake (reservoir) inorganic nitrogen/orthophosphorus weight ratios.

1. Algal Assays -

Depending on the size and/or complexity of the water body, one or more depth-integrated (through the photic zone) samples were collected during the last sampling visit (1972), first visit

(1973), or the first and last sampling visits (1974 and 1975). The samples were shipped to CERL, and algal assays were performed to determine the limiting nutrient and the potential primary productivity of the water body at the time the sample was taken (U.S. EPA, 1971). The growth response of the test alga, Selenastrum capricornutum Prinz, to spikes of phosphorus or nitrogen indicated the limiting nutrient. In all cases, the assay results were evaluated with respect to the nutrient levels and ratios in the water body at the times and places the samples were collected; when there were substantial differences, the assay results were not considered representative of conditions in the water body at the time of sampling, and the in-water-body N/P ratios were used to determine the limiting nutrient.

In a few of the assay samples, there was no growth response to phosphorus and nitrogen, alone or in combination, indicating limitation by some other element or by some other factor such as toxicity. In other samples, growth response occurred only when phosphorus and nitrogen were added in combination, indicating co-limitation; in the latter cases, the control sample inorganic N/P ratios generally were about 13/1.

2. N/P Ratios -

Although phytosynthetic productivity requires both phosphorus and nitrogen, the optimal proportions of the two elements may vary considerably, depending on the kind of organism. Some of the weight ratios reported range from 11/1 for Selenastrum capricornutum (grown in culture medium; Miller, 1973) to 60/1 for Microcystis aeruginosa (total N/total P; Gerloff and Skoog, 1957), but an inorganic weight ratio of about 15/1 is frequently reported (e.g., Middlebrooks et.al., 1971; Schindler, 1971; Vollenweider, 1968; Vollenweider and Dillon, 1974). Considering the apparent co-limitation at 13/1 noted above and the 15/1 ratio, the NES selected an inorganic N/P ratio of 14/1 as an approximation to determine the limiting nutrient at those sampling times when no algal assay samples were collected or when the assay results were suspect. Since one of the primary objectives of the Survey was to evaluate the need for control of phosphorus inputs to the water bodies, the selected N/P ratio is considered conservative.

In larger lakes, and particularly in reservoirs, the assessment of limiting nutrient was done on a station-by-station basis. In many such water bodies, marked nitrogen limitation occurred near point-source impacts and/or in major tributary embayments while the main partion of the water body was phosphorus-limited.

Also, for some water bodies in which phosphorus and nitrogen levels were relatively high but chlorophyll a levels, phytoplankton numbers, and transparency were low, the possibility of light limitation was indicated.

We have not attempted a comparison of the NES assessment of limiting nutrient with those of others since N/P ratios reported to be limiting vary widely, as noted above.

D. Tributary Nutrient Levels -

Before comparing the NES stream nutrient data, it is useful to evaluate variances that occur in the measurement of nutrients and other parameters in streams. For this purpose, we retrieved from STORET (EPA's Storage and Retrieval computer system) data collected over varying periods of time by the U.S. Geological Survey at five hydrologic bench-mark stream sampling stations, two National stream-quality accounting network stations, and three sampling stations on other streams. The sampling stations were selected to illustrate variances in stream quality in various parts of the conterminous United States.

In water-data reports (e.g., Anonymous, 1976), the Geological Survey defines a hydrologic bench-mark station as "...one that provides hydrologic data for a basin in which the hydrologic regimen will likely be governed solely by natural conditions. Data collected... may be used to separate effects of natural from manmade changes in other basins that have been developed...". In the same publications, the objectives of National stream-quality accounting network stations are stated as "... (1) to depict areal variability of water-quality conditions... on a year-by-year basis and (2) to detect and assess long-term changes in stream quality".

The National network stations are on the Colorado River above Imperial Dam, Arizona and California, and the Missouri River at Pierre, South Dakota.

The bench-mark stations are:

Castle Creek, South Dakota
Elder Creek, California
Esopus Creek, New York
Upper Three Runs, South Carolina
Wet Bottom Creek, Arizona

The other stream stations include the Hudson River at Green Island, New York; The North Branch Potomac River near Cumberland, Maryland; and the Willamette River at Salem, Oregon. These streams were selected not only to demonstrate geographical differences but also to represent some differences in point-source impacts. For example, the Willamette River receives treated domestic wastes and a variety of treated industrial wastes upstream from the sampling station, whereas the North Branch Potomac River station is far upstream in the ridge and valley province of the Appalachian Mountains and has relatively little point-source impact, if any.

The data for the ten stations are presented on the following pages as reproductions of portions of the STORET data retrievals. Parameters of particular interest, represented by at least 15 samples, are indicated by double-pointed arrows in the space to the left of the column headed "Number".

Beginning with "Number" (of samples), the column headings are "Mean" ($\bar{x}$), "Variance" (s^2), "Stan Dev" (s), "Coef Var" (V; coefficients shown multiplied by 100 are equivalent to V values in percent elsewhere in this report), "Stan Er" (standard error of the mean), "Maximum" and "Minimum" (range of values), and "Beg Date" (beginning date) and "End Date" (ending date) is the period of record.

The ten-stream data indicate stream parameters are at least as variable as the lake parameters previously examined, if not more so. Further, the greater variability of nutrient parameters as compared to more-conservative parameters (e.g., conductivity, alkalinity, and dissolved calcium) is evident. This is more easily seen in the following tabulation of the coefficients of variation (X 100) of three nutrient parameters and one conservative parameter for the five bench-mark stations.

Coefficients of Variation

Stream	Sol. Reactive P (Ortho P04)	Total P	Nitrite + Nitrate	Conductivity
Castle Cr.	154	69	64	10
Elder Cr.	133	132	145	22
Esopus Cr.	-	125	58	19
Upper Three Runs	-	172	18	27
Wet Bottom Cr.	103	-	178	.52

Considering the variability of the data, it would be expected that some between-year differences in nutrient parameters will occur. We have made a number of such comparisons using U.S. Geological Survey

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COLORADO R AB IMPERIAL D ARIZ-CA
06025 CALIFORNIA
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112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	15	603468	.100E+12	317680	.526433	100461	760195	223.000	73/07/18	75/08/05
00010	WATER	TEMP	CENT	133	20.4420	42.9330	6.55233	.320533	.568159	30.0000	1.80000	71/10/14	76/11/22
00020	AIR	TEMP	CENT	71	30.6478	616.505	24.8295	.810156	2.94672	225.000	12.0000	71/10/15	76/11/22
00060	STREAM	FLOW	CFS	238	8233.08	6729745	2594.18	.315091	168.155	12800.0	1140.00	71/10/06	76/11/29
00061	STREAM	FLOW,	INST-CFS	97	8315.94	7645568	2765.06	.332502	280.749	13300.0	2140.00	72/10/19	76/11/22
00070	TURB	JKSN	JTU	63	1.58570	.497723	.705495	.444911	.088884	4.00000	.999999	73/12/03	75/06/09
00076	TURB	TRBIDMTR	HACH FTU	96	5.12496	160.741	12.6784	2.47385	1.29398	120.000	.999999	75/02/03	76/11/29
00095	CNDUCTVY	AT 25C	MICROMHO	314	1332.76	8555.14	92.4940	.069400	5.21974	1730.00	1070.00	71/10/06	76/11/29
00300	DO		MG/L	52	8.67110	.763308	.873675	.100757	.121157	10.7000	7.40000	71/10/15	76/11/10
00340	COD	HI LEVEL	MG/L	60	11.1667	40.6159	6.37306	.570722	.822759	36.0000	.000000	74/05/15	76/11/22
00400	PH		SU	262	8.08270	.027404	.165540	.020481	.010227	8.39999	7.10000	71/10/06	76/11/29
00405	CO2		MG/L	199	2.62053	4.00069	2.00017	.763269	.141789	26.0000	1.20000	72/07/12	76/11/29
00410	T ALK	CACO3	MG/L	230	146.357	64.4017	8.02507	.054832	.529157	182.000	113.000	71/10/06	76/11/29
00440	HCO3 ION	HCO3	MG/L	230	178.454	96.0611	9.80108	.054922	.646264	222.000	138.000	71/10/06	76/11/29
00445	CO3 ION	CO3	MG/L	225	.008889	.017778	.133333	15.0000	.008889	2.00000	.000000	71/10/06	76/11/29
00515	RESIDUE	DISS-105	C MG/L	10	927.000	3269.00	57.1752	.061678	18.0804	1000.000	840.000	71/10/18	76/07/14
00530	RESIDUE	TOT NFLT	MG/L	65	24.9231	1700.98	41.2429	1.65481	5.11555	265.000	.000000	71/10/18	76/11/22
00550	OIL-GRSE	TOT-SXLT	MG/L	3	.666667	1.33333	1.15470	1.73205	.666667	2.00000	.000000	74/05/15	74/07/10
00572	BIOMASS	PERPHYTN	G/SQ M	8	4.60912	61.7917	7.86077	1.70548	2.77920	23.0000	.200000	74/11/05	76/09/15
00573	BIOMASS	PERPHYTN	DW G/M2	7	7.06714	81.2211	9.01228	1.27524	3.40632	26.0000	.300000	75/02/11	76/09/15
00600	TOTAL N	N	MG/L	60	.563497	.070982	.266425	.472806	.034395	2.20000	.140000	74/05/15	76/11/22
00605	ORG N	N	MG/L	59	.363219	.034771	.186471	.513385	.024276	1.20000	.020000	74/05/15	76/11/22
00610	NH3-N	TOTAL	MG/L	59	.025593	.001080	.032867	1.28422	.004279	.210000	.000000	74/05/15	76/11/22
00613	NO2-N	DISS	MG/L	70	.002857	.000021	.004550	1.59256	.000544	.010000	.000000	72/11/01	76/11/10
00615	NO2-N	TOTAL	MG/L	57	.005789	.000032	.005653	.976406	.000749	.020000	.000000	74/05/15	76/11/22
00618	NO3-N	DISS	MG/L	104	.227497	.034734	.186372	.819227	.018275	1.80000	.050000	72/11/01	76/11/29
00620	NO3-N	TOTAL	MG/L	57	.174035	.016003	.126503	.726883	.016756	.980001	.030000	74/05/15	76/11/22
00625	TOT KJEL	N	MG/L	60	.389498	.033733	.183665	.472756	.023711	1.20000	.030000	74/05/15	76/11/22
00630	NO2&NO3	N-TOTAL	MG/L	60	.175000	.016158	.127112	.726358	.016410	1.00000	.010000	74/05/15	76/11/22
00631	NO2&NO3	N-DISS	MG/L	92	.285540	.242883	.492831	1.72596	.051381	4.60000	.060000	71/10/06	76/11/10
00660	ORTHOPO4	PO4	MG/L	85	.023765	.001340	.036612	1.54060	.003971	.250000	.000000	71/10/06	76/11/10
00665	PHOS-TOT		MG/L P	59	.034068	.002718	.052131	1.53022	.006787	.360000	.000000	74/05/15	76/11/22
00666	PHOS-DIS		MG/L P	11	.007273	.000102	.010091	1.38744	.003042	.030000	.000000	74/05/15	76/1 /10
00671	PHOS-DIS	ORTHO	MG/L P	85	.007882	.000143	.011962	1.51752	.001297	.080000	.000000	71/10/06	76/11/10
00680	T ORG C	C	MG/L	58	5.33619	26.7126	5.16900	.968668	.678723	38.0000	2.20000	74/05/15	76/11/22
00900	TOT HARD	CACO3	MG/L	230	368.693	249.362	15.7912	.042830	1.04124	439.999	298.000	71/10/06	76/11/29
00902	NC HARD	CACO3	MG/L	231	222.209	101.313	10.0654	.045297	.662257	258.000	164.000	71/10/06	76/11/29
00915	CALCIUM	CA,DISS	MG/L	230	94.0361	25.7554	5.07498	.053968	.334634	114.000	79.0000	71/10/06	76/1 /29
00916	CALCIUM	CA-TOT	MG/L	10	90.1000	166.326	12.8968	.143138	4.07831	120.000	69.0000	74/05/15	76/1 /10

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06440000
44 22 25.0 100 22 20.0 2
MISSOURI RIVER AT PIERRE S DAK
46117 SOUTH DAKOTA
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PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	84	10.5642	46.5701	6.82423	.645975	.744584	22.0000	.000000	72/08/29	76/10/14
00020	AIR	TEMP	CENT	14	10.4143	160.018	12.6498	1.21466	3.38080	26.4000	-.179E+02	72/08/29	73/09/19
00060	STREAM	FLOW	CFS	57	34820.5	.149E+09	12222.4	.351012	1618.90	54199.9	.050000	71/07/22	73/09/30
00061	STREAM	FLOW,	INST-CFS	55	43129.0	.165E+09	12880.2	.298643	1736.77	57800.0	10800.0	73/10/16	76/10/14
00070	TURB	JKSN	JTU	23	2.65217	2.69171	1.64064	.618603	.342097	7.00000	1.00000	74/05/10	76/09/29
00095	CNDUCTVY	AT 25C	MICROMHO	111	733.404	1739.05	41.7020	.056861	3.95817	870.000	648.000	71/07/22	76/10/14
00300	DO		MG/L	19	11.5210	3.76625	1.94068	.168447	.445223	14.4000	7.99999	72/08/29	74/01/10
00310	BOD	5 DAY	MG/L	18	.883332	.039118	.197784	.223906	.046618	1.20000	.599999	72/08/29	74/01/10
00400	PH		SU	111	8.24587	.144496	.380126	.046099	.036080	10.2000	7.40000	71/07/22	76/10/14
00405	CO2		MG/L	83	2.20602	2.72686	1.65132	.748552	.181256	12.0000	.200000	71/07/22	76/10/14
00410	T ALK	CACO3	MG/L	94	156.191	44.2581	6.65267	.042593	.686171	173.000	126.000	71/07/22	76/10/14
00440	HCO3 ION	HCO3	MG/L	94	188.606	77.8279	8.82201	.046775	.909921	211.000	154.000	71/07/22	76/10/14
00445	CO3 ION	CO3	MG/L	91	.956044	5.22027	2.28479	2.38984	.239511	11.0000	.000000	71/07/31	76/10/14
00572	BIOMASS	PERPHYTN	G/SQ M	6	.780833	.718518	.847654	1.08558	.346053	2.30000	.077000	74/11/04	76/09/29
00573	BIOMASS	PERPHYTN	DW G/M2	5	1.20680	1.13707	1.06634	.883607	.476880	2.40000	.154000	75/07/08	76/09/29
00600	TOTAL N	N	MG/L	41	.476340	.051145	.226154	.474773	.035319	1.40000	.120000	72/08/29	76/09/29
00605	ORG N	N	MG/L	17	.235882	.022563	.150211	.636805	.036432	.640001	.070000	72/08/29	74/01/10
00608	NH3-N	DISS	MG/L	6	.028333	.000337	.018349	.647595	.007491	.060000	.010000	72/08/29	73/01/10
00610	NH3-N	TOTAL	MG/L	13	.036923	.001190	.034493	.934177	.009567	.140000	.000000	72/12/04	74/01/10
00613	NO2-N	DISS	MG/L	17	.002353	.000019	.004372	1.85826	.001060	.010000	.000000	72/08/29	74/01/10
00618	NO3-N	DISS	MG/L	17	.298235	.056790	.238307	.799058	.057798	.930001	.130000	72/08/29	74/01/10
00625	TOT KJEL	N	MG/L	41	.281951	.016476	.128359	.455254	.020046	.660001	.000000	72/08/29	76/09/29
00630	NO2&NO3	N-TOTAL	MG/L	35	.165714	.021107	.145283	.876709	.024557	.920001	.050000	73/02/27	76/09/29
00631	NO2&NO3	N-DISS	MG/L	73	.220411	.018818	.137178	.622374	.016055	.940001	.040000	71/07/22	76/10/14
00660	ORTHOPO4	PO4	MG/L	68	.034412	.001324	.036380	1.05721	.004412	.150000	.000000	71/08/25	76/10/14
00665	PHOS-TOT		MG/L P	92	.042065	.007351	.085736	2.03818	.008939	.800001	.000000	71/07/22	76/10/14
00666	PHOS-DIS		MG/L P	59	.019830	.000502	.022399	1.12951	.002916	.150000	.000000	71/12/31	76/10/14
00671	PHOS-DIS	ORTHO	MG/L P	68	.011471	.000147	.012127	1.05721	.001471	.050000	.000000	71/08/25	76/10/14
00680	T ORG C	C	MG/L	9	4.44444	6.86780	2.62065	.589646	.873549	11.0000	2.20000	74/10/04	76/07/27
00900	TOT HARD	CACO3	MG/L	94	193.808	5082.19	71.2895	.367835	7.35295	260.000	5.00000	71/07/22	76/10/14
00902	NC HARD	CACO3	MG/L	94	58.4148	758.122	27.5340	.471353	2.83992	95.0000	.000000	71/07/22	76/10/14
00915	CALCIUM	CA,DISS	MG/L	94	46.7999	389.928	19.7466	.421936	2.03670	65.0000	.600000	71/07/22	76/10/14
00925	MGNSIUM	MG,DISS	MG/L	94	18.7563	32.6182	5.71123	.304496	.589069	24.0000	.500000	71/07/22	76/10/14
00930	SODIUM	NA,DISS	MG/L	94	85.1489	1978.65	44.4821	.522403	4.58797	240.000	56.0000	71/07/22	76/10/14
00931	SODIUM	ADSBTION	RATIO	94	4.60421	61.1834	7.82198	1.69887	.806776	48.0000	1.70000	71/07/22	76/10/14
00932	PERCENT	SODIUM	%	94	46.8829	376.562	19.4052	.413907	2.00149	98.0000	35.0000	71/07/22	76/10/14
00935	PTSSIUM	K,DISS	MG/L	94	4.76378	.196927	.443764	.093154	.045771	7.20000	3.80000	71/07/22	76/10/14
00940	CHLORIDE	CL	MG/L	94	9.92655	1.40104	1.18366	.119241	.122085	14.0000	7.90000	71/07/22	76/10/14
00945	SULFATE	SO4-TOT	MG/L	94	201.702	156.237	12.4995	.061970	1.28922	230.000	170.000	71/07/22	76/10/14

STORET DATE 77/04/13

06409000
44 00 49.0 103 49 48.0 2
CASTLE CR ABV DEERFIELD RES, NR
46103 SOUTH DAKOTA
090491

/TYPA/AMBNT/STREAM

112WRD 0400100[illegible]
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	2	376087	.281E+12	530414	1.41035	375060	751146	1027.00	[illegible]/11/26	74/10/[illegible]
00010	WATER	TEMP	CENT	191	5.36831	30.3435	5.50850	1.02611	.398581	18.5000	-.100E+01	[illegible]/12/31	76/12/[illegible]
00020	AIR	TEMP	CENT	63	9.64275	115.511	10.7476	1.11458	1.35407	33.5000	-.115E+02	[illegible]/10/14	76/0[illegible]
00060	STREAM	FLOW	CFS	146	12.8707	22.9405	4.78962	.372132	.396392	42.0000	2.10000	[illegible]/12/31	73/04/[illegible]
00061	STREAM	FLOW,	INST-CFS	91	11.4989	19.1527	4.37638	.380596	.458769	34.0000	2.10000	[illegible]/10/27	76/12/[illegible]
00063	NO. OF	SAMPLING	POINTS	2	8.00000	2.00000	1.41421	.176777	1.00000	9.00000	7.00000	6[illegible]/09/19	68/04/[illegible]
00065	STREAM	STAGE	FEET	19	2.22684	3.47690	1.86464	.837352	.427779	6.00000	.499E-06	[illegible]/11/18	71/11/[illegible]
00080	COLOR	PT-CO	UNITS	27	6.00000	15.0770	3.88291	.647151	.747266	17.0000	1.00000	6[illegible]/03/10	71/04/[illegible]
00095	CNDUCTVY	AT 25C	MICROMHO	175	462.077	2302.34	47.9828	.103842	3.62716	639.999	304.000	6[illegible]/12/31	76/12/[illegible]
00300	DO		MG/L	88	10.0079	1.99506	1.41247	.141135	.150569	13.1000	6.00000	6[illegible]/09/19	75/06/[illegible]
00310	BOD	5 DAY	MG/L	82	.989384	.262606	.512451	.517949	.056591	3.40000	.100000	6[illegible]/10/22	73/09/[illegible]
00400	PH		SU	171	8.22212	.182238	.426893	.051920	.032645	9.69999	6.60000	6[illegible]/12/31	76/12/[illegible]
00405	CO2		MG/L	53	3.31131	10.2960	3.20874	.969023	.440754	21.0000	.100000	71/03/09	76/12/[illegible]
00410	T ALK	CACO3	MG/L	112	245.332	456.594	21.3681	.087098	2.01909	288.000	182.000	65/[illegible]5/16	76/12/[illegible]
00440	HCO3 ION	HCO3	MG/L	123	297.715	764.541	27.6503	.092875	2.49315	351.000	180.000	64/12/31	76/12/[illegible]
00445	CO3 ION	CO3	MG/L	113	.734514	9.57175	3.09383	4.21207	.291043	22.0000	.000000	64/12/31	76/12/[illegible]
00515	RESIDUE	DISS-105	C MG/L	13	273.077	1889.78	43.4716	.159192	12.0568	390.000	220.000	67/09/19	75/10/[illegible]
00530	RESIDUE	TOT NFLT	MG/L	13	8.38461	88.5896	9.41221	1.12256	2.61048	29.0000	1.000000	67/09/19	75/10/[illegible]
00615	NO2-N	TOTAL	MG/L	1	.050000					.050000	.050000	71/03/09	71/03/0[illegible]
00618	NO3-N	DISS	MG/L	31	.129032	.014702	.121253	.939715	.021778	.410000	.000000	6[illegible]/[illegible]0/14	71/04/1[illegible]
00630	NO2&NO3	N-TOTAL	MG/L	38	.155263	.014723	.121338	.781504	.019684	.630001	.010000	7[illegible]/[illegible]1/25	76/12/1[illegible]
00631	NO2&NO3	N-DISS	MG/L	31	.132580	.008627	.092879	.700549	.016682	.320000	.000000	71/[illegible]/11	76/09/1[illegible]
00650	T PO4	PO4	MG/L	20	.184000	.038615	.196506	1.06797	.043940	.560000	.499E-06	65/[illegible]/15	68/09/1[illegible]
00660	ORTHOPO4	PO4	MG/L	59	.047966	.005458	.073877	1.54020	.009618	.480000	.000000	67/[illegible]/22	73/10/30
00665	PHOS-TOT		MG/L P	70	.038000	.000744	.027272	.717695	.003260	.140000	.000000	70/[illegible]/15	76/12/1[illegible]
00666	PHOS-DIS		MG/L P	48	.039667	.002074	.045544	1.14817	.006574	.270001	.000000	68/[illegible]/1[illegible]	73/10/30
00671	PHOS-DIS	ORTHO	MG/L P	27	.010000	.000131	.011435	1.14354	.002201	.040000	.000000	70/[illegible]/11	73/10/30
00680	T ORG C	C	MG/L	3	25.1666	1255.58	35.4341	1.40798	20.4579	65.9999	2.50000	68/[illegible]/1[illegible]	73/11/2[illegible]
00720	CYANIDE	CN-TOT	MG/L	8	.006250	.000198	.014079	2.25262	.004978	.040000	.000000	73/[illegible]/25	76/10/20
00900	TOT HARD	CACO3	MG/L	123	250.764	449.541	21.2024	.084551	1.91175	291.000	186.000	64/[illegible]/31	76/12/13
00902	NC HARD	CACO3	MG/L	123	6.67885	68.5184	8.27758	1.23937	.746365	48.0000	.000000	64/[illegible]/31	76/12/13
00915	CALCIUM	CA,DISS	MG/L	123	52.4551	57.9155	7.61022	.145081	.686190	66.0000	25.0000	64/[illegible]/31	76/12/13
00925	MGNSIUM	MG,DISS	MG/L	123	29.1869	4.75973	2.18168	.074748	.196716	40.0000	20.0000	64/[illegible]/31	76/12/13
00930	SODIUM	NA,DISS	MG/L	123	1.86422	.635078	.796918	.427480	.071856	6.70000	.500000	64/[illegible]	76/12/13
00931	SODIUM	ADSRTION	RATIO	112	.050000	.002703	.051988	1.03976	.004912	.200000	.000000	64/[illegible]	76/12/13
00932	PERCENT	SODIUM	%	121	1.52066	.501656	.708278	.465770	.064389	5.00000	.499E-06	65/[illegible]	76/12/13
00935	PTSSIUM	K,DISS	MG/L	123	1.50894	.431146	.656617	.435152	.059205	5.10000	.700000	64/[illegible]	76/12/13
00940	CHLORIDE	CL	MG/L	122	1.46475	.980630	.990268	.676067	.089655	10.00000	.400000	64/[illegible]	76/12/13
00945	SULFATE	SO4-TOT	MG/L	123	7.38692	7.19307	2.68199	.363073	.241827	22.0000	.300000	64/[illegible]	76/12/13

STORET DATE 77/01/28

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39 43 47.0 123 38 34.0 2
ELDER CREEK NEAR BRANSCOMB CALIF
06045 CALIFORNIA
140291

/TYPA/AMBNT/STREAM

112WRD 0400100
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00004	STREAM	WIDTH	FEET	12	22.9666	96.0415	9.80008	.426710	2.82904	36.0000	3.50000	73/10/04	74/09/03
00008	LAB	IDENT.	NUMBER	4	755954	.300E+08	5482.62	.007253	2741.31	760837	751067	74/10/14	75/09/22
00010	WATER	TEMP	CENT	159	10.4999	13.1307	3.62363	.345113	.287373	20.5000	2.50000	68/06/14	76/09/16
00020	AIR	TEMP	CENT	17	12.9412	30.9964	5.56744	.430211	1.35030	24.5000	5.99999	70/01/21	75/07/18
00060	STREAM	FLOW	CFS	80	45.3070	8957.49	94.6440	2.08895	10.5815	556.000	.500000	68/02/15	71/09/21
00061	STREAM	FLOW,	INST-CFS	91	73.1465	20322.7	142.558	1.94893	14.9441	647.999	.669999	71/10/18	76/09/16
00063	NO. OF	SAMPLING	POINTS	4	4.00000	8.66664	2.94392	.735980	1.47196	7.99999	1.00000	69/11/21	74/01/17
00075	TURB	HLGE	PPM SIO2	1	2.00000					2.00000	2.00000	68/02/15	68/02/15
00080	COLOR	PT-CO	UNITS	2	3.50000	4.50000	2.12132	.606091	1.50000	5.00000	2.00000	68/06/14	70/02/19
00095	CNDUCTVY	AT 25C	MICROMHO	93	107.577	546.609	23.3797	.217329	2.42436	158.000	48.9999	68/02/15	76/09/16
00300	DO		MG/L	80	10.5736	1.10517	1.05127	.099424	.117536	13.3000	8.20000	68/06/14	76/09/16
00301	DO	SATUR	PERCENT	57	97.5935	25.7288	5.07236	.051974	.671850	108.000	80.0000	68/06/14	76/09/16
00310	BOD	5 DAY	MG/L	24	.724999	.953264	.976353	1.34669	.199297	3.60000	.499E-06	68/06/14	71/06/14
00400	PH		SU	99	7.47264	.176459	.420070	.056214	.042219	8.70000	6.30000	68/02/15	76/08/10
00405	CO2		MG/L	41	4.48048	14.7926	3.84611	.858415	.600662	16.0000	.600000	71/10/19	76/08/10
00410	T ALK	CACO3	MG/L	89	49.0364	109.111	10.4456	.213018	1.10723	69.0000	25.0000	68/02/15	76/09/16
00440	HCO3 ION	HCO3	MG/L	75	60.5199	169.959	13.0368	.215414	1.50537	84.0000	30.0000	68/02/15	76/09/16
00445	CO3 ION	CO3	MG/L	69	.144E-06	.522E-13	.228E-06	1.57672	.275E-07	.499E-06	.000000	68/02/15	76/08/10
00515	RESIDUE	DISS-105	C MG/L	13	74.1537	166.823	12.9160	.174179	3.58225	88.0000	49.0000	68/03/14	76/01/26
00530	RESIDUE	TOT NFLT	MG/L	13	1.61538	2.75641	1.66024	1.02777	.460468	7.00000	1.000000	68/03/14	76/01/26
00600	TOTAL N	N	MG/L	10	.420000	.168934	.411016	.978608	.129975	1.50000	.070000	68/10/02	73/02/22
00605	ORG N	N	MG/L	27	.285926	.136802	.369868	1.29358	.071181	1.50000	.000000	68/06/14	73/02/22
00608	NH3-N	DISS	MG/L	6	.036667	.001187	.034448	.939491	.014063	.080000	.000000	71/05/25	73/02/22
00610	NH3-N	TOTAL	MG/L	3	.036667	.001033	.032146	.876696	.018559	.060000	.000000	73/01/17	75/07/18
00615	NO2-N	TOTAL	MG/L	28	.003929	.000047	.006853	1.74429	.001295	.020000	.000000	74/01/22	76/09/16
00620	NO3-N	TOTAL	MG/L	28	.039643	.004129	.064261	1.62100	.012144	.270000	.000000	74/01/22	76/09/16
00625	TOT KJEL	N	MG/L	16	.180000	.031333	.177012	.983402	.044253	.580000	.000000	69/10/23	73/02/22
00630	NO2&NO3	N-TOTAL	MG/L	30	.042333	.003750	.061233	1.44646	.011180	.270000	.000000	73/01/17	76/09/16
00631	NO2&NO3	N-DISS	MG/L	49	.031224	.005194	.072071	2.30818	.010296	.430000	.000000	71/05/25	76/08/10
00650	T PO4	PO4	MG/L	25	.176400	.035024	.187147	1.06092	.037429	.990000	.060000	68/02/15	71/02/09
00653	SOLPO4-T	PO4	MG/L	1	.070000					.070000	.070000	70/02/19	70/02/19
00660	ORTHOPO4	PO4	MG/L	29	.121724	.026300	.162174	1.33231	.030115	.860000	.000000	68/06/14	73/02/22
00665	PHOS-TOT		MG/L P	49	.048979	.004172	.064590	1.31872	.009227	.450000	.000000	71/05/25	76/09/16
00671	PHOS-DIS	ORTHO	MG/L P	6	.040000	.000560	.023664	.591608	.009661	.080000	.010000	71/05/25	73/02/22
00680	T ORG C	C	MG/L	2	2.50000	4.49998	2.12132	.848527	1.50000	4.00000	1.000000	72/07/18	73/10/04
00720	CYANIDE	CN-TOT	MG/L	6	.000000	.000000	.000000		.000000	.000000	.000000	74/06/19	76/09/16
00900	TOT HARD	CACO3	MG/L	76	42.2631	85.9558	9.27124	.219369	1.06348	62.0000	21.0000	68/02/15	76/09/16
00902	NC HARD	CACO3	MG/L	76	.802631	45.7872	6.76662	8.43055	.776185	59.0000	.000000	68/02/15	76/09/16
00915	CALCIUM	CA,DISS	MG/L	76	11.1302	6.25448	2.50090	.224694	.286872	16.0000	5.40000	68/02/15	76/09/16

STORET DATE 77/01/28

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ESOPUS CREEK AT SHANDAKEN, NY
36111 NEW YORK
013292

/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	16	213463	.713E+12	844409	3.95577	211102	3379993	332.000	71/03/23	73/10/18
00010	WATER	TEMP	CENT	132	8.91657	49.0658	7.00470	.785582	.609681	26.5000	.000000	66/11/15	76/09/22
00020	AIR	TEMP	CENT	89	12.6740	103.327	10.1650	.802036	1.07749	28.0000	-.149E+02	69/01/29	76/09/22
00060	STREAM	FLOW	CFS	100	141.118	32145.3	179.291	1.27050	17.9291	1040.00	4.40000	63/08/20	74/03/26
00061	STREAM	FLOW.	INST-CFS	55	147.649	31288.6	176.886	1.19802	23.8513	1160.00	5.49999	72/10/05	76/09/22
00065	STREAM	STAGE	FEET	58	7.74199	387.349	19.6812	2.54213	2.58427	155.000	4.15000	68/10/31	74/03/26
00075	TURB	HLGE	PPM SIO2	7	.600000	.110000	.331663	.552772	.125357	1.000000	.000000	63/08/20	65/02/16
00080	COLOR	PT-CO	UNITS	60	4.34998	65.4171	8.08808	1.85934	1.04417	55.0000	.000000	63/08/20	71/05/25
00095	CNDUCTVY	AT 25C	MICROMHO	131	53.6097	99.4115	9.97053	.185984	.871129	100.000	37.0000	63/08/20	76/09/22
00300	DO		MG/L	110	11.4526	3.85765	1.96409	.171497	.187269	16.6000	4.60000	67/09/19	76/09/22
00301	DO	SATUR	PERCENT	54	98.7406	101.187	10.0592	.101875	1.36888	113.000	53.0000	69/11/06	76/09/22
00310	BOD	5 DAY	MG/L	60	.867829	.723787	.850757	.980327	.109832	4.00000	.000000	67/10/25	73/09/11
00400	PH		SU	129	7.03789	.141693	.376421	.053485	.033142	8.70000	6.19999	63/08/20	76/09/22
00405	CO2		MG/L	51	2.83333	9.05384	3.00896	1.06199	.421339	12.0000	.100000	72/01/26	76/09/22
00410	T ALK	CACO3	MG/L	118	10.7542	16.1700	4.02119	.373917	.370180	21.0000	2.00000	64/03/31	76/09/22
00440	HCO3 ION	HCO3	MG/L	120	13.1741	24.2362	4.92303	.373691	.449409	25.0000	2.40000	63/08/20	76/09/22
00445	CO3 ION	CO3	MG/L	110	.109E-06	.430E-13	.207E-06	1.90164	.197E-07	.499E-06	.000000	64/10/27	76/09/22
00505	RESIDUE	TOT VOL	MG/L	22	5.77272	17.8030	4.21936	.730915	.899571	14.0000	.000000	69/06/26	71/05/25
00515	RESIDUE	DISS-105	C MG/L	12	39.1666	569.430	23.8627	.609263	6.88858	110.000	19.0000	67/09/19	75/10/20
00530	RESIDUE	TOT NFLT	MG/L	12	11.4167	771.354	27.7733	2.43270	8.01745	98.0000	.999999	67/09/19	75/10/20
00605	ORG N	N	MG/L	27	.113704	.072478	.269218	2.36771	.051811	1.40000	.000000	68/08/07	71/02/19
00608	NH3-N	DISS	MG/L	3	.076667	.001733	.041633	.543044	.024037	.110000	.030000	71/07/01	73/07/17
00610	NH3-N	TOTAL	MG/L	1	.000000					.000000	.000000	72/01/26	72/01/26
00613	NO2-N	DISS	MG/L	6	.006667	.000046	.006802	1.02029	.002777	.018000	.000000	71/07/01	73/09/11
00615	NO2-N	TOTAL	MG/L	6	.004500	.000019	.004416	.981308	.001803	.010000	.000000	73/10/18	74/03/26
00618	NO3-N	DISS	MG/L	22	.179999	.017486	.132234	.734634	.028192	.500000	.000000	71/07/01	73/09/11
00620	NO3-N	TOTAL	MG/L	10	.369999	.027667	.166333	.449549	.052599	.599999	.010000	72/01/26	74/03/26
00630	NO2&NO3	N-TOTAL	MG/L	34	.231235	.018112	.134582	.582015	.023081	.519999	.010000	73/10/18	76/09/22
00631	NO2&NO3	N-DISS	MG/L	3	.246666	.009733	.098658	.399964	.056960	.360000	.180000	73/05/30	73/09/11
00650	T PO4	PO4	MG/L	4	.070000	.005400	.073485	1.04978	.036742	.180000	.030000	72/06/06	72/09/07
00660	ORTHOPO4	PO4	MG/L	1	.020000					.020000	.020000	72/10/05	72/10/05
00665	PHOS-TOT		MG/L P	64	.015359	.000370	.019241	1.25275	.002405	.140000	.000000	70/11/24	76/09/22
00666	PHOS-DIS		MG/L P	1	.000000					.000000	.000000	71/10/01	71/10/01
00680	T ORG C	C	MG/L	2	.250000	.125000	.353553	1.41421	.250000	.500000	.000000	72/09/07	73/10/18
00720	CYANIDE	CN-TOT	MG/L	3	.000000	.000000	.000000		.000000	.000000	.000000	74/05/15	76/07/09
00900	TOT HARD	CACO3	MG/L	119	18.7406	11.7478	3.42750	.182892	.314199	27.0000	12.0000	63/08/20	76/09/22
00902	NC HARD	CACO3	MG/L	119	7.85709	4.97130	2.22964	.283774	.204391	13.0000	1.00000	63/08/20	76/09/22
00915	CALCIUM	CA,DISS	MG/L	120	5.54325	1.34129	1.15814	.208928	.105723	9.00000	3.20000	63/08/20	76/09/22
00925	MGNSIUM	MG,DISS	MG/L	120	1.21583	.056816	.238360	.196048	.021759	2.30000	.800000	63/08/20	76/09/22

STORET DATE 77/01/28

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UPPER THREE RUNS NR NEW ELLENTON
45003 SOUTH CAROLINA
031391

/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	2	376267	.281E+12	530868	1.41088	375381	751647	886.000	73/10/29	74/11/27
00010	WATER	TEMP	CENT	156	15.9530	15.7980	3.97467	.249148	.318228	23.0000	8.99999	67/11/02	76/12/03
00060	STREAM	FLOW	CFS	133	119.065	1194.14	34.5563	.290230	2.99641	229.000	77.9999	67/11/02	73/09/21
00061	STREAM	FLOW.	INST-CFS	54	155.147	3951.55	62.8613	.405174	8.55434	549.999	106.000	72/10/24	76/12/03
00080	COLOR	PT-CO	UNITS	56	10.1428	71.2892	8.44329	.832442	1.12828	40.0000	2.00000	67/11/02	73/10/29
00095	CNDUCTVY	AT 25C	MICROMHO	136	15.8742	17.9512	4.23688	.266904	.363310	49.9999	12.0000	67/11/02	76/11/11
00300	DO		MG/L	80	9.27117	1.50208	1.22559	.132194	.137025	11.8000	6.70000	67/11/02	76/11/11
00301	DO	SATUR	PERCENT	1	97.0000					97.0000	97.0000	68/08/05	68/08/05
00310	BOD	5 DAY	MG/L	10	3.70000	106.280	10.3092	2.78628	3.26006	33.0000	.499E-06	68/10/07	71/06/11
00400	PH		SU	129	5.89844	.269562	.519193	.089386	.045712	7.60000	4.40000	67/11/02	76/11/11
00405	CO2		MG/L	28	5.43214	39.1704	6.25863	1.15215	1.18277	32.0000	.000000	72/10/24	76/11/11
00410	T ALK	CACO3	MG/L	76	2.38158	1.19913	1.09505	.459799	.125611	6.00000	.000000	67/11/02	76/11/11
00440	HCO3 ION	HCO3	MG/L	76	2.93420	2.00892	1.41736	.483048	.162583	7.00000	.000000	67/11/02	76/11/11
00445	CO3 ION	CO3	MG/L	74	.189E-06	.596E-13	.244E-06	1.29049	.283E-07	.499E-06	.000000	67/11/02	76/11/11
00515	RESIDUE	DISS-105	C MG/L	13	19.1538	36.1416	6.01179	.313869	1.66737	35.0000	11.0000	67/11/02	75/11/18
00530	RESIDUE	TOT NFLT	MG/L	13	4.53846	11.9359	3.45484	.761237	.958200	12.0000	2.00000	67/11/02	75/11/18
00613	NO2-N	DISS	MG/L	1	.020000					.020000	.020000	73/10/29	73/10/29
00615	NO2-N	TOTAL	MG/L	5	.014000	.000666	.025807	1.84336	.011541	.060000	.000000	72/12/12	73/06/21
00618	NO3-N	DISS	MG/L	8	.083750	.003341	.057802	.690171	.020436	.200000	.020000	71/10/08	73/10/29
00620	NO3-N	TOTAL	MG/L	5	.233999	.031180	.176579	.754613	.078968	.539999	.100000	72/12/12	73/06/21
00630	NO2&NO3	N-TOTAL	MG/L	20	.198000	.001312	.036218	.182918	.008099	.270000	.110000	73/12/12	76/11/11
00631	NO2&NO3	N-DISS	MG/L	1	.040000					.040000	.040000	73/10/29	73/10/29
00650	T PO4	PO4	MG/L	17	.835885	11.5086	3.39243	4.05849	.822785	14.0000	.000000	67/11/02	70/07/01
00660	ORTHOPO4	PO4	MG/L	10	.011000	.000388	.019692	1.79012	.006227	.060000	.000000	68/10/07	71/08/20
00665	PHOS-TOT		MG/L P	43	.005861	.000102	.010080	1.71991	.001537	.060000	.000000	69/07/11	76/11/11
00666	PHOS-DIS		MG/L P	1	.499E-06					.499E-06	.499E-06	69/09/05	69/09/05
00680	T ORG C	C	MG/L	4	5.87500	45.7294	6.76235	1.15104	3.38118	16.0000	2.00000	68/12/04	73/10/29
00720	CYANIDE	CN-TOT	MG/L	8	.000000	.000000	.000000		.000000	.000000	.000000	72/04/24	76/11/11
00900	TOT HARD	CACO3	MG/L	76	2.97368	2.26596	1.50531	.506211	.172671	9.00000	1.00000	67/11/02	76/11/11
00902	NC HARD	CACO3	MG/L	76	.947367	2.05053	1.43197	1.51152	.164258	7.00000	.000000	67/11/02	76/11/11
00915	CALCIUM	CA.DISS	MG/L	76	.701312	.276401	.525739	.749651	.060306	3.00000	.100000	67/11/02	76/11/11
00925	MGNSIUM	MG.DISS	MG/L	76	.298682	.013733	.117188	.392350	.013442	.600000	.000000	67/11/02	76/11/11
00930	SODIUM	NA.DISS	MG/L	76	1.27105	.098360	.313624	.246744	.035975	3.40000	.200000	67/11/02	76/11/11
00931	SODIUM	ADSRTION	RATIO	76	.342102	.016606	.128863	.376681	.014782	1.10000	.000000	67/11/02	76/11/11
00932	PERCENT	SODIUM	%	76	47.1184	135.813	11.6539	.247332	1.33679	77.0000	5.00000	67/11/02	76/11/11
00935	PTSSIUM	K.DISS	MG/L	76	.285524	.032455	.180154	.630958	.020665	1.40000	.100000	67/11/02	76/11/11
00940	CHLORIDE	CL	MG/L	76	2.31578	.283724	.532657	.230012	.061100	3.70000	.200000	67/11/02	76/11/11
00945	SULFATE	SO4-TOT	MG/L	76	.942136	.411266	.641300	.680687	.073562	3.00000	.000000	67/11/02	76/11/11
00950	FLUORIDE	F.DISS	MG/L	75	.081333	.028836	.169812	2.08785	.019608	1.30000	.000000	67/11/02	76/11/11

STORET DATE 77/01/28

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/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	4	563790	.140E+12	375225	.665540	187612	751403	952.000	73/11/14	74/11/14
00010	WATER	TEMP	CENT	109	14.6480	50.1759	7.08349	.483580	.678476	32.0000	.150000	68/02/27	76/10/12
00020	AIR	TEMP	CENT	9	16.3333	94.9379	9.74361	.596549	3.24787	35.0000	8.50000	71/08/12	74/02/11
00060	STREAM	FLOW	CFS	96	13.2995	1205.82	34.7249	2.61100	3.54409	176.000	.000000	68/02/27	75/07/24
00061	STREAM	FLOW,	INST-CFS	32	31.1980	2634.87	51.3309	1.64533	9.07411	176.000	.040000	72/10/05	76/10/12
00070	TURB	JKSN	JTU	1	.999999					.999999	.999999	70/02/23	70/02/23
00075	TURB	HLGE	PPM SIO2	5	.680000	.087000	.294958	.433762	.131909	1.00000	.400000	69/11/12	70/10/15
00080	COLOR	PT-CO	UNITS	19	8.26316	87.9827	9.37991	1.13515	2.15190	30.0000	3.00000	68/08/21	70/10/15
00095	CNDUCTVY	AT 25C	MICROMHO	77	263.909	18602.2	136.390	.516806	15.5431	580.000	6.00000	68/08/21	76/10/12
00300	DO		MG/L	27	8.05925	2.08328	1.44336	.179093	.277774	10.00000	5.40000	68/08/21	74/02/11
00400	PH		SU	77	7.56485	.474404	.688770	.091049	.078493	8.70000	5.50000	68/08/21	76/10/12
00405	CO2		MG/L	32	3.61562	11.6665	3.41563	.944686	.603803	15.0000	.300000	70/02/23	76/10/12
00410	T ALK	CACO3	MG/L	65	115.031	4774.46	69.0975	.600686	8.57049	251.000	13.0000	68/08/21	76/10/12
00440	HCO3 ION	HCO3	MG/L	66	137.424	7216.40	84.9494	.618155	10.4565	306.000	.000000	68/08/21	76/10/12
00445	CO3 ION	CO3	MG/L	54	.425926	1.72082	1.31180	3.07988	.178514	6.00000	.000000	68/08/21	76/10/12
00515	RESIDUE	DISS-105	C MG/L	11	182.454	8666.07	93.0917	.510219	28.0682	290.000	51.0000	68/01/29	75/11/14
00530	RESIDUE	TOT NFLT	MG/L	11	3.18181	19.5636	4.42307	1.39011	1.33361	15.0000	1.000000	68/01/29	75/11/14
00613	NO2-N	DISS	MG/L	18	.001111	.000022	.004714	4.24264	.001111	.020000	.000000	72/11/28	75/04/14
00618	NO3-N	DISS	MG/L	19	.069474	.022528	.150092	2.16041	.034433	.680001	.000000	70/02/23	75/04/14
00631	NO2&NO3	N-DISS	MG/L	47	.079149	.019764	.140585	1.77622	.020506	.700001	.000000	70/12/15	76/10/12
00650	T PO4	PO4	MG/L	14	.117143	.068868	.262427	2.24023	.070136	1.00000	.000000	68/08/21	70/10/15
00660	ORTHOPO4	PO4	MG/L	46	.041956	.001865	.043185	1.02929	.006367	.210000	.000000	70/12/15	76/10/12
00671	PHOS-DIS	ORTHO	MG/L P	44	.013409	.000214	.014618	1.09016	.002204	.070000	.000000	71/03/30	76/10/12
00720	CYANIDE	CN-TOT	MG/L	3	.003333	.000033	.005774	1.73205	.003333	.010000	.000000	74/12/13	76/10/12
00900	TOT HARD	CACO3	MG/L	65	97.7077	2845.44	53.3427	.545942	6.61635	240.000	22.0000	68/08/21	76/10/12
00902	NC HARD	CACO3	MG/L	65	1.84615	12.6322	3.55418	1.92518	.440842	13.0000	.000000	68/08/21	76/10/12
00915	CALCIUM	CA,DISS	MG/L	66	26.3515	219.274	14.8079	.561938	1.82272	62.0000	.000000	68/08/21	76/10/12
00925	MGNSIUM	MG,DISS	MG/L	66	7.36965	18.5925	4.31191	.585090	.530759	20.0000	.000000	68/08/21	76/10/12
00930	SODIUM	NA,DISS	MG/L	66	18.4318	115.512	10.7476	.583104	1.32294	40.0000	.000000	68/08/21	76/10/12
00931	SODIUM	ADSBTION	RATIO	65	.796919	.131244	.362276	.454596	.044935	2.50000	.200000	68/08/21	76/10/12
00932	PERCENT	SODIUM	%	65	28.5231	37.6608	6.13684	.215153	.761181	65.0000	17.0000	68/08/21	76/10/12
00935	PTSSIUM	K,DISS	MG/L	66	1.21212	.186629	.432006	.356406	.053176	2.30000	.000000	68/08/21	76/10/12
00940	CHLORIDE	CL	MG/L	66	8.75149	28.8254	5.36893	.613488	.660870	30.0000	.000000	68/08/21	76/10/12
00945	SULFATE	SO4-TOT	MG/L	66	9.12421	17.9825	4.24058	.464761	.521979	28.0000	.000000	68/08/21	76/10/12
00950	FLUORIDE	F,DISS	MG/L	66	1.29393	.452589	.672747	.519924	.082809	2.70000	.000000	68/08/21	76/10/12
00955	SILICA	DISOLVED	MG/L	66	26.7424	84.9651	9.21765	.344683	1.13461	45.0000	.000000	68/08/21	76/10/12
01000	ARSENIC	AS,DISS	UG/L	4	7.25000	21.5833	4.64579	.640798	2.32289	12.0000	1.00000	74/12/13	76/10/12
01005	BARIUM	BA,DISS	UG/L	4	50.0000	3333.33	57.7350	1.15470	28.8675	100.000	.000000	74/12/13	76/10/12
01020	BORON	B,DISS	UG/L	66	56.0605	6891.93	83.0177	1.48086	10.2188	670.000	.000000	68/08/21	76/10/12

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HUDSON RIVER AT GREEN ISLAND NY
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/TYPA/AMBNT/STREAM

112WRD 04001004
0002 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00005	VSAMPLOC	DEPTH	% OF TOT	9	99.9998	.015625	.125000	.001250	.041667	99.9998	99.9998	75/08/14	75/08/14
00008	LAB	IDENT.	NUMBER	13	1611.76	960547	980.075	.608076	271.824	2986.99	61.9999	71/01/20	73/09/18
00009	XSAMPLOC	FT FROM	LF BANK	34	336.762	22229.3	149.095	.442730	25.5696	589.999	59.9999	75/08/14	75/09/08
00010	WATER	TEMP	CENT	149	13.3033	83.2334	9.12323	.685786	.747404	25.0000	.000000	65/11/05	76/09/24
00020	AIR	TEMP	CENT	91	12.3722	102.999	10.1488	.820298	1.06389	30.0000	-.799E+01	68/01/28	76/09/24
00027	COLLECT	AGENCY	CODE	1	1028.00					1028.00	1028.00	73/02/21	73/02/21
00028	ANALYZE	AGENCY	CODE	1	1028.00					1028.00	1028.00	73/02/21	73/02/21
00060	STREAM	FLOW	CFS	177	10411.6	.110E+09	10491.6	1.00769	788.600	60700.0	15.5000	63/06/27	75/09/08
00061	STREAM	FLOW,	INST-CFS	25	15397.9	.138E+09	11779.4	.765000	2355.88	59399.9	3279.99	72/10/26	75/11/05
00065	STREAM	STAGE	FEET	75	17.1135	2.87854	1.69662	.099140	.195909	20.8000	7.00000	68/01/28	74/09/05
00070	TURB	JKSN	JTU	25	7.84000	23.0567	4.80174	.612466	.960347	20.0000	1.000000	64/09/10	76/09/24
00075	TURB	HLGE	PPM SIO2	25	.943994	.781738	.884159	.936615	.176832	3.00000	.000000	63/06/27	64/09/30
00080	COLOR	PT-CO	UNITS	100	23.9399	118.500	10.8858	.454712	1.08858	85.0000	5.00000	63/06/27	75/05/06
00095	CNDUCTVY	AT 25C	MICROMHO ⟷	230	192.555	1722.50	41.5030	.215539	2.73663	387.000	101.000	63/06/27	76/09/24
00300	DO		MG/L	58	10.1758	7.30715	2.70317	.265648	.354944	15.0000	5.10000	71/10/21	76/09/24
00301	DO	SATUR	PERCENT	46	94.6607	88.1764	9.39023	.099199	1.38451	112.000	76.9999	72/10/26	76/09/24
00335	COD	LOWLEVEL	MG/L	73	14.3697	30.3217	5.50651	.383203	.644488	38.0000	5.00000	69/04/23	75/05/06
00400	PH		SU	204	7.20432	.193119	.439453	.060998	.030768	8.20000	4.20000	63/06/27	76/09/24
00405	CO2		MG/L	47	11.9463	2753.32	52.4721	4.39452	7.65384	363.000	.700000	72/05/23	76/09/24
00410	T ALK	CACO3	MG/L ⟷	135	48.6074	125.287	11.1932	.230277	.963354	80.0000	21.0000	63/11/28	76/09/24
00440	HCO3 ION	HCO3	MG/L	204	58.4348	182.813	13.5208	.231383	.946648	97.9999	.499E-06	63/06/27	76/09/24
00445	CO3 ION	CO3	MG/L	163	.171E-06	.567E-13	.238E-06	1.38657	.186E-07	.499E-06	.000000	64/10/06	76/09/24
00500	RESIDUE	TOTAL	MG/L	51	121.372	769.536	27.7405	.228558	3.88445	207.000	74.9999	71/01/20	75/05/06
00505	RESIDUE	TOT VOL	MG/L	28	17.3928	90.2491	9.49995	.546201	1.79532	53.0000	5.00000	68/03/26	71/04/26
00510	RESIDUE	TOT FIX	MG/L	53	92.6222	633.209	25.1636	.271681	3.45649	173.000	48.9999	68/03/26	75/05/06
00515	RESIDUE	DISS-105	C MG/L	47	114.574	1150.53	33.9195	.296048	4.94766	230.000	.000000	68/10/25	76/09/24
00525	RESIDUE	FIX FLT	MG/L	19	14.2631	425.427	20.6259	1.44610	4.73190	95.0000	.000000	71/02/26	72/09/21
00530	RESIDUE	TOT NFLT	MG/L	88	14.2454	250.428	15.8249	1.11088	1.68694	108.000	.000000	68/10/25	76/09/24
00540	RESIDUE	FIX NFLT	MG/L	32	8.01874	72.4627	8.51250	1.06158	1.50481	41.9999	.000000	72/10/26	75/05/06
00572	BIOMASS	PERPHYTN	G/SQ M	5	1.41520	5.32214	2.30698	1.63014	1.03171	5.53000	.200000	75/11/24	76/09/20
00573	BIOMASS	PERPHYTN	DW G/M2	5	1.61420	5.64055	2.37498	1.47131	1.06212	5.84000	.200000	75/11/24	76/09/20
00600	TOTAL N	N	MG/L	48	1.15802	.095268	.308655	.266538	.044550	1.82900	.480000	70/10/22	76/09/24
00605	ORG N	N	MG/L	81	.414872	.293574	.541825	1.30601	.060203	4.80000	.040000	68/07/26	75/05/06
00608	NH3-N	DISS	MG/L	27	.215592	.024498	.156520	.726000	.030122	.649999	.010000	71/07/20	73/09/18
00610	NH3-N	TOTAL	MG/L ⟷	20	.199000	.011367	.106618	.535771	.023841	.380000	.000000	73/10/25	75/05/06
00613	NO2-N	DISS	MG/L	27	.033481	.001570	.039623	1.18345	.007626	.130000	.001000	71/07/20	73/09/18
00615	NO2-N	TOTAL	MG/L	20	.021950	.001218	.034902	1.59007	.007804	.160000	.000000	73/10/25	75/05/06
00618	NO3-N	DISS	MG/L	28	.616428	.021543	.146775	.238106	.027738	.919999	.390000	71/07/20	73/09/18
00620	NO3-N	TOTAL	MG/L	20	.541500	.018950	.137660	.254220	.030782	.880000	.320000	73/10/25	75/05/06
00625	TOT KJEL	N	MG/L ⟷	36	.469166	.021443	.146433	.312113	.024406	.750001	.190000	73/02/21	76/09/24
00630	NO2&NO3	N-TOTAL	MG/L ⟷	32	.527812	.017986	.134110	.254087	.023708	.889999	.320000	73/10/25	76/09/24
00631	NO2&NO3	N-DISS	MG/L	5	.701999	.041720	.204256	.290963	.091346	.919999	.400000	73/05/22	73/09/18
00650	T PO4	PO4	MG/L	10	.226000	.023982	.154862	.685232	.048972	.640000	.110000	66/04/20	72/09/21
00660	ORTHOPO4	PO4	MG/L	18	.075555	.002591	.050900	.673684	.011997	.210000	.020000	72/10/26	74/03/22
00665	PHOS-TOT		MG/L P ⟷	68	.062661	.001178	.034320	.547709	.004162	.210000	.014000	70/10/22	76/09/24
00671	PHOS-DIS	ORTHO	MG/L P ⟷	24	.025667	.000236	.015364	.598604	.003136	.068000	.006000	72/04/19	74/03/22
00680	T ORG C	C	MG/L	16	5.60000	9.52799	3.08675	.551205	.771686	15.0000	3.00000	74/08/08	76/08/26
00720	CYANIDE	CN-TOT	MG/L	1	.000000					.000000	.000000	73/02/21	73/02/21
00900	TOT HARD	CACO3	MG/L	190	70.2157	207.525	14.4057	.205164	1.04510	116.000	36.0000	63/06/27	76/09/24
00902	NC HARD	CACO3	MG/L	190	27.2838	586.310	24.2138	.887481	1.75666	127.000	9.00000	63/06/27	76/09/24
00915	CALCIUM	CA,DISS	MG/L ⟷	180	21.2388	19.7521	4.44433	.209255	.331261	34.0000	11.0000	63/06/27	76/09/24

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NORTH BRANCH POTOMAC RIVER NEAR
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/TYPA/AMBNT/STREAM 112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	12	2935644	.103E+15	.101E+08	3.46107	2933111	.351E+08	639.999	72/12/12	74/01/23
00010	WATER	TEMP	CENT	183	13.6565	78.9690	8.88645	.650712	.656905	32.2200	.000000	60/09/29	76/11/01
00020	AIR	TEMP	CENT	20	14.6500	96.9496	9.84630	.672104	2.20170	27.0000	.500000	74/02/28	76/09/01
00060	STREAM	FLOW	CFS	157	2338.54	.150E+08	3876.66	1.65772	309.391	21000.0	111.000	63/05/16	72/09/28
00061	STREAM	FLOW,	INST-CFS	78	2746.85	.134E+08	3665.86	1.33457	415.076	18400.0	152.000	71/11/30	76/11/01
00065	STREAM	STAGE	FEET	27	3.83888	4.40740	2.09938	.546874	.404026	12.4500	2.20000	73/04/27	76/09/01
00070	TURB	JKSN	JTU	9	37.8888	2329.86	48.2686	1.27396	16.0895	160.000	2.00000	69/10/02	73/12/05
00080	COLOR	PT-CO	UNITS	120	13.7249	591.443	24.3196	1.77193	2.22007	180.000	.000000	60/09/29	76/11/01
00085	ODOR	THRSH NO	RM. TEMP	4	17.2500	342.250	18.5000	1.07246	9.25000	45.0000	8.00000	61/04/18	71/09/30
00095	CNDUCTVY	AT 25C	MICROMHO	213	431.971	62453.4	249.907	.578527	17.1233	1090.00	110.000	06/09/20	76/11/01
00300	DO		MG/L	60	9.40492	10.7117	3.27288	.347996	.422527	13.9000	1.50001	60/09/29	74/01/23
00301	DO	SATUR	PERCENT	2	58.0000	.000000	.000000		.000000	58.0000	58.0000	60/09/29	61/04/18
00310	BOD	5 DAY	MG/L	9	3.73332	15.4926	3.93606	1.05430	1.31202	14.0000	1.10000	69/10/02	73/12/05
00335	COD	LOWLEVEL	MG/L	3	18.6666	212.334	14.5717	.780627	8.41296	35.0000	6.99999	73/03/13	73/12/05
00400	PH		SU	185	6.81936	.311078	.557743	.081788	.041006	7.80000	4.60000	60/09/29	76/11/01
00405	CO2		MG/L	92	7.57275	96.8061	9.83901	1.29926	1.02579	71.0000	.499E-06	63/05/16	76/11/01
00410	T ALK	CACO3	MG/L	166	26.7529	352.446	18.7735	.701738	1.45711	84.0000	.000000	06/09/20	76/11/01
00435	T ACDITY	CACO3	MG/L	4	17.2500	570.222	23.8793	1.38431	11.9397	52.9999	3.40000	73/09/14	73/12/05
00440	HCO3 ION	HCO3	MG/L	179	36.2623	704.150	26.5358	.731774	1.98338	144.000	.499E-06	06/09/20	76/11/01
00445	CO3 ION	CO3	MG/L	148	.162162	1.61924	1.27249	7.84704	.104595	12.0000	.000000	06/09/20	76/11/01
00515	RESIDUE	DISS-105	C MG/L	2	590.000	1800.00	42.4264	.071909	30.0000	620.000	560.000	72/09/28	73/09/14
00530	RESIDUE	TOT NFLT	MG/L	8	69.9999	18640.2	136.529	1.95042	48.2703	406.999	5.00000	69/10/02	73/09/14
00608	NH3-N	DISS	MG/L	3	.543333	.003634	.060283	.110950	.034804	.600000	.479999	72/07/19	73/09/14
00610	NH3-N	TOTAL	MG/L	1	.400000					.400000	.400000	73/12/05	73/12/05
00613	NO2-N	DISS	MG/L	2	.006500	.000024	.004950	.761500	.003500	.010000	.003000	73/06/06	73/09/14
00615	NO2-N	TOTAL	MG/L	6	.007500	.000037	.006058	.807739	.002473	.017000	.000000	73/10/17	74/04/01
00618	NO3-N	DISS	MG/L	25	.517999	.033184	.182163	.351667	.036433	.799999	.140000	71/10/27	73/09/14
00620	NO3-N	TOTAL	MG/L	7	.691428	.015981	.126417	.182835	.047781	.800000	.470000	72/06/23	74/04/01
00630	NO2&NO3	N-TOTAL	MG/L	33	.612725	.041299	.203220	.331667	.035376	1.10000	.220000	73/10/17	76/11/01
00631	NO2&NO3	N-DISS	MG/L	2	.599999	.020001	.141425	.235709	.100003	.699999	.500000	73/06/06	73/09/14
00650	T PO4	PO4	MG/L	16	.151875	.063216	.251428	1.65550	.062857	.900000	.000000	65/05/18	72/09/28
00665	PHOS-TOT		MG/L P	36	.088805	.012815	.113202	1.27472	.018867	.659999	.006000	69/10/02	76/11/01
00720	CYANIDE	CN-TOT	MG/L	10	.006000	.000049	.006992	1.16534	.002211	.020000	.000000	61/04/18	73/12/05
00900	TOT HARD	CACO3	MG/L	152	164.755	7662.27	87.5344	.531300	7.09998	385.000	43.0000	60/09/29	76/11/01
00902	NC HARD	CACO3	MG/L	152	134.466	5504.62	74.1931	.551763	6.01786	313.000	22.0000	60/09/29	76/11/01
00915	CALCIUM	CA,DISS	MG/L	175	45.4500	755.489	27.4862	.604756	2.07776	127.000	12.0000	06/09/20	76/11/01
00925	MGNSIUM	MG,DISS	MG/L	173	9.22072	33.9816	5.82937	.632204	.443199	45.0000	2.50000	06/09/20	76/11/01
00930	SODIUM	NA,DISS	MG/L	149	24.8811	507.979	22.5384	.905845	1.84642	102.000	2.50000	60/09/29	76/11/01
00931	SODIUM	ADSRTION	RATIO	136	.710288	.201821	.449245	.632483	.038522	2.70000	.200000	60/09/29	76/11/01

STORET DATE 77/01/26

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WILLAMETTE RIVER AT SALEM.OREG.
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/TYPA/AMBNT/STREAM

112WRD 0400100
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PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00028	LAB	IDENT.	NUMBER	2	979.500	261365	511.239	.521938	361.500	1341.00	618.000	73/09/19	74/01/29
00010	WATER	TEMP	CENT	13	12.0000	31.2750	5.59240	.443842	1.55105	20.0000	4.70000	70/06/15	76/07/14
00060	STREAM	FLOW	CFS	262	28810.7	.107E+10	32743.7	1.13651	2022.91	285000	625.000	59/10/20	73/09/19
00061	STREAM	FLOW,	INST-CFS	17	28016.5	.442E+09	21032.1	.750707	5101.04	71799.8	6981.00	73/06/26	76/06/03
00080	COLOR	PT-CO	UNITS	8	10.0000	78.5714	8.86405	.886405	3.13391	20.0000	.499E-06	67/10/23	69/03/01
00095	CNDUCTVY	AT 25C	MICROMHO	278	61.9792	178.101	13.3455	.215321	.800407	141.000	7.10000	59/10/20	76/07/14
00400	PH		SU	271	6.89990	.228602	.478124	.069294	.029044	9.80000	4.80000	59/10/20	76/06/03
00405	CO2		MG/L	17	2.92352	8.60566	2.93354	1.00343	.711489	9.60000	.200000	72/10/18	76/06/03
00410	T ALK	CACO3	MG/L	225	20.2933	21.5831	4.64577	.228931	.309718	42.0000	7.00000	60/10/28	76/07/14
00440	HCO3 ION	HCO3	MG/L	277	24.4184	33.4678	5.78514	.236917	.347595	51.0000	.499E-06	59/10/20	76/07/14
00445	CO3 ION	CO3	MG/L	215	.097675	.873598	.934664	9.56916	.063744	11.0000	.000000	60/10/28	76/06/03
00515	RESIDUE	DISS-105	C MG/L	17	46.4117	40.8887	6.39443	.137776	1.55088	60.0000	39.0000	70/11/11	74/01/29
00530	RESIDUE	TOT NFLT	MG/L	17	21.4706	344.139	18.5510	.864019	4.49927	73.0000	7.00000	70/11/11	74/01/29
00600	TOTAL N	N	MG/L	1	.440000					.440000	.440000	72/03/22	72/03/22
00625	TOT KJEL	N	MG/L	2	.345000	.011250	.106066	.307439	.075000	.420000	.270000	71/04/28	72/03/22
00631	NO2&NO3	N-DISS	MG/L	35	.550856	.161427	.401780	.729375	.067913	1.50000	.070000	70/12/17	76/07/14
00665	PHOS-TOT		MG/L P	21	.069047	.002709	.052049	.753810	.011358	.270000	.010000	70/12/17	76/07/14
00900	TOT HARD	CACO3	MG/L	278	20.1867	10.1742	3.18970	.158010	.191306	38.0000	12.0000	59/10/20	76/07/14
00902	NC HARD	CACO3	MG/L	278	1.30935	5.98338	2.44610	1.86818	.146707	15.0000	.000000	59/10/20	76/07/14
00915	CALCIUM	CA,DISS	MG/L	170	5.41226	.588596	.767200	.141752	.058842	8.80000	3.80000	59/10/20	76/07/14
00925	MGNSIUM	MG,DISS	MG/L	169	1.76211	.087747	.296221	.168105	.022786	2.60000	.700000	59/10/20	76/07/14
00930	SODIUM	NA,DISS	MG/L	278	3.77295	.826184	.908947	.240912	.054515	11.0000	2.10000	59/10/20	76/07/14
00931	SODIUM	ADSBTION	RATIO	265	.387917	.172355	.415157	1.07022	.025503	7.00000	.200000	59/10/20	76/07/14
00932	PERCENT	SODIUM	%	228	28.2149	9.92373	3.15020	.111650	.208627	43.0000	19.0000	60/10/28	76/07/14
00935	PTSSIUM	K,DISS	MG/L	90	.884440	.952795	.976112	1.10365	.102891	8.80000	.200000	59/10/20	76/07/14
00940	CHLORIDE	CL	MG/L	88	3.16363	2.23294	1.49430	.472338	.159293	7.90000	.000000	59/10/20	76/07/14
00945	SULFATE	SO4-TOT	MG/L	81	3.75801	2.57578	1.60492	.427067	.178325	8.00000	.200000	59/10/20	76/07/14
00950	FLUORIDE	F,DISS	MG/L	86	.093023	.007009	.083723	.900020	.009028	.400000	.000000	59/10/20	76/07/14
00955	SILICA	DISOLVED	MG/L	84	14.3583	5.22581	2.28600	.159211	.249423	17.0000	4.30000	59/10/20	76/07/14
01020	BORON	B,DISS	UG/L	37	9.19023	229.859	15.1611	1.64970	2.49247	70.0000	.000000	59/10/20	68/10/04
01046	IRON	FE,DISS	UG/L	36	101.944	6210.40	78.8061	.773030	13.1343	340.000	10.0000	70/12/17	76/07/14
01056	MANGNESE	MN,DISS	UG/L	1	7.00000					7.00000	7.00000	72/06/08	72/06/08
01515	ALPHA-D	AS U-NAT	PC/L	14	.150000	.005769	.075956	.506374	.020300	.300000	.100000	70/11/11	72/10/18
01516	ALPHA-S	AS U-NAT	PC/L	14	.235714	.048626	.220514	.935515	.058935	.800000	.100000	70/11/11	72/10/18
03515	BETA-D	AS CS137	PC/L	17	1.23529	.084929	.291427	.235917	.070681	1.70000	.700000	70/11/11	74/01/29
03516	BETA-S	AS CS137	PC/L	17	.864705	.373673	.611288	.706932	.148259	2.60000	.400000	70/11/11	74/01/29
09503	RA-226	DISOLVED	PC/L	8	.030000	.000086	.009258	.308608	.003273	.040000	.020000	69/10/09	70/09/30
09510	RA-226-D	PLCHT CT	PC/L	1	.100000					.100000	.100000	72/10/18	72/10/18
09511	RA-226-D	RADON MT	PC/L	16	.027500	.000233	.015275	.555463	.003819	.070000	.010000	70/11/11	74/01/29

data from sampling stations of several years of record. Significant between-year differences can be demonstrated for essentially all of the nutrient parameters, and the comparisons are on file at CERL.

One example of difference is shown in the following comparison of U.S.G.S. data for water years 1973 and 1974 at the same station on the Big Sioux River in eastern South Dakota. The nutrient parameters compared are indicated by the arrows. While the means of five of the six parameters do not differ significantly, the null hypotheses of no difference between the means of total phosphorus for the two years (underlined) is rejected at the 0.05 probability level ($t = 2.295$ with 36 d. f.).

In our assessment of the reliability of the NES tributary data, for the most part we found it necessary to utilize STORET again because of a scarcity of published stream data. After some effort we were able to retrieve comparable data obtained by other agencies (primarily U.S.G.S.) at or near nine of the 4,000+ NES sampling stations. The data were selectively retrieved to provide periods of record that are comparable to the NES sampling times.

The evaluations are shown on the following pages as reproductions of the data retrievals, and the parameters compared are indicated by the double-pointed arrows. On the first page, the agency codes are circled in the headings (112WRD is the code for the Water Resources Division of U.S.G.S., 11EPALES is the NES code, and 21CAL-1 is the code for the California Department of Water Resources).

In only five of the 32 parameter comparisons shown were the means of the NES data and other agency data significantly different at the 0.05 level as indicated by Student's t-tests. The five are indicated by the underlined parameter names (e.g., "00610 NH3-N" in the Hackensack River data). It will be noted that none of the means of the phosphorus species differed significantly and that only two of the five differing comparisons involve a parameter that would affect calculated nutrient loads ("00625 TOT KJEL").

The NES stream data also were compared to data reported by the Georgia Department of Natural Resources (Anonymous, 1974), the Illinois Environmental Protection Agency (Anonymous, 1972), and the Wisconsin Department of Natural Resources (Anonymous, 1975).

In 1973, the Georgia DNR collected from 4 to 14 samples at seven comparable sites on five streams from which 13 or 14 samples were collected by the NES during the period of March 1973 through February, 1974. There is excellent agreement between DNR and NES total phosphorus data (the mean of all DNR TP data is 228 μg/l and the mean of all NES data is 227 μg/l; the coefficient of rank correlation is 1.00, $n = 7$).

STORET DATE 77/03/16

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BIG SIOUX R NR DELL RAPIDS,S.DAK
46099 SOUTH DAKOTA
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/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	24	10.8166	102.030	10.1010	.933836	2.06185	26.5000	.000000	72/10/26	73/09/27
00020	AIR	TEMP	CENT	12	11.3583	121.502	11.0228	.970461	3.18201	30.0000	-.199E+01	72/10/26	73/09/27
00060	STREAM	FLOW	CFS	35	246.683	125520	354.288	1.43620	59.8856	1770.00	18.0000	72/10/26	73/09/30
00095	CNDUCTVY	AT 25C	MICROMHO	35	860.484	12194.3	110.428	.128332	18.6657	1200.00	585.000	72/10/26	73/09/30
00300	DO		MG/L	12	10.7250	8.58212	2.92953	.273150	.845681	15.8000	5.00000	72/10/26	73/09/27
00310	BOD	5 DAY	MG/L	12	3.89165	1.16270	1.07829	.277077	.311275	6.59999	2.50000	72/10/26	73/09/27
00400	PH		SU	35	8.02855	.141752	.376500	.046895	.063640	9.09999	7.40000	72/10/26	73/09/30
00405	CO2		MG/L	23	6.54347	15.0453	3.87882	.592778	.808791	19.0000	2.90000	72/10/26	73/09/30
00410	T ALK	CACO3	MG/L	23	217.617	1853.23	43.0491	.197820	8.97636	323.000	146.000	72/10/26	73/09/30
00440	HCO3 ION	HCO3	MG/L	23	265.260	2759.18	52.5279	.198024	10.9528	394.000	178.000	72/10/26	73/09/30
00445	CO3 ION	CO3	MG/L	23	.000000	.000000	.000000		.000000	.000000	.000000	72/10/26	73/09/30
00600	TOTAL N	N	MG/L	12	2.59166	.891761	.944331	.364372	.272605	4.30000	1.40000	72/10/26	73/09/27
00605	ORG N	N	MG/L	12	1.55500	.315861	.562015	.361424	.162240	2.70000	.780000	72/10/26	73/09/27
00608	NH3-N	DISS	MG/L	4	.452500	.167292	.409013	.903897	.204507	1.00000	.080000	72/10/26	73/01/30
00610	NH3-N	TOTAL	MG/L	10	.382000	.109840	.331421	.867595	.104804	1.00000	.050000	72/12/20	73/09/27
00613	NO2-N	DISS	MG/L	12	.019167	.000572	.023916	1.24779	.006904	.080000	.000000	72/10/26	73/09/27
00618	NO3-N	DISS	MG/L	12	.599167	.564863	.751574	1.25436	.216961	2.10000	.000000	72/10/26	73/09/27
00625	TOT KJEL	N	MG/L	12	1.90000	.276371	.525710	.276690	.151759	2.90000	1.20000	72/10/26	73/09/27
00630	NO2&NO3	N-TOTAL	MG/L	8	.487500	.531050	.728732	1.49483	.257646	2.10000	.000000	73/02/21	73/09/27
00631	NO2&NO3	N-DISS	MG/L	23	1.03956	.937209	.968096	.931255	.201862	3.40000	.000000	72/10/26	73/09/30
00660	ORTHOPO4	PO4	MG/L	22	.451818	.151177	.388815	.860557	.082896	1.40000	.000000	72/10/26	73/09/30
00665	PHOS-TOT		MG/L P	23	.258261	.017688	.132995	.514963	.027731	.530000	.100000	72/10/26	73/09/30
00666	PHOS-DIS		MG/L P	14	.242143	.021203	.145612	.601348	.038916	.520000	.020000	72/10/26	73/09/30
00671	PHOS-DIS	ORTHO	MG/L P	22	.147727	.015980	.126414	.855723	.026951	.440000	.000000	72/10/26	73/09/30
00900	TOT HARD	CACO3	MG/L	23	386.956	2995.18	54.7283	.141433	11.4116	510.000	270.000	72/10/26	73/09/30

00600	TOTAL N	N	MG/L	14	2.42142	.583367	.763785	.315428	.204130	4.20000	1.60000	73/11/08	74/09/16
00605	ORG N	N	MG/L	14	1.59428	.369384	.607769	.381218	.162433	2.90000	.400000	73/11/08	74/09/16
00610	NH3-N	TOTAL	MG/L	14	.454286	.235457	.485239	1.06814	.129686	1.50000	.040000	73/11/08	74/09/16
00613	NO2-N	DISS	MG/L	3	.033333	.000533	.023094	.692820	.013333	.060000	.020000	73/11/08	74/01/10
00618	NO3-N	DISS	MG/L	3	.873334	1.36003	1.16621	1.33535	.673309	2.20000	.010000	73/11/08	74/01/10
00625	TOT KJEL	N	MG/L	14	2.04286	.113414	.336770	.164852	.090005	3.00000	1.60000	73/11/08	74/09/16
00630	NO2&NO3	N-TOTAL	MG/L	15	.376000	.362783	.602315	1.60190	.155517	2.30000	.000000	73/11/08	74/09/16
00631	NO2&NO3	N-DISS	MG/L	9	.390000	.566525	.752678	1.92994	.250893	2.30000	.000000	73/11/08	74/09/05
00660	ORTHOPO4	PO4	MG/L	9	.365555	.163028	.403767	1.10453	.134589	1.20000	.030000	73/11/08	74/09/05
00665	PHOS-TOT		MG/L P	15	.360000	.018086	.134483	.373565	.034723	.550000	.130000	73/11/08	74/09/16
00666	PHOS-DIS		MG/L P	6	.138333	.020057	.141622	1.02377	.057817	.410000	.020000	74/03/06	74/09/05
00671	PHOS-DIS	ORTHO	MG/L P	9	.120000	.017900	.133791	1.11493	.044597	.400000	.010000	73/11/08	74/09/05
00680	T ORG C	C	MG/L	12	11.9750	11.8639	3.44440	.287633	.994313	19.0000	8.10000	74/03/06	74/09/16
00900	TOT HARD	CACO3	MG/L	9	388.333	17825.1	133.511	.343805	44.5036	620.000	95.0000	73/11/08	74/09/05

STORET DATE 77/03/16

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CASTLE CR ABV DEERFIELD RES. NR
46103 SOUTH DAKOTA
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/TYPA/AMBNT/STREAM

112WPD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	1	751146					751146	751146	74/10/15	74/10/15
00010	WATER	TEMP	CENT	13	5.11537	35.5063	5.95872	1.16486	1.65265	18.5000	.000000	74/10/15	75/09/10
00020	AIR	TEMP	CENT	1	5.00000					5.00000	5.00000	74/11/25	74/11/25
00061	STREAM	FLOW.	INST-CFS	13	10.7692	17.7773	4.21631	.391515	1.16939	22.0000	6.49999	74/10/15	75/09/10
00095	CNDUCTVY	AT 25C	MICROMHO	12	501.833	3140.27	56.0381	.111667	16.1768	610.000	395.000	74/10/15	75/09/10
00300	DO		MG/L	6	10.9500	1.23511	1.11135	.101494	.453708	12.2000	9.39999	74/10/15	75/06/10
00400	PH		SU	12	8.44999	.155495	.394329	.046666	.113833	9.00000	7.70000	74/10/15	75/09/10
00405	CO2		MG/L	11	2.51817	8.32167	2.88473	1.14556	.869779	10.0000	.400000	74/10/15	75/09/10
00410	T ALK	CACO3	MG/L	11	250.818	334.575	18.2914	.072927	5.51506	270.000	214.000	74/10/15	75/09/10
00440	HCO3 ION	HCO3	MG/L	11	303.545	477.762	21.8578	.072008	6.59037	329.000	261.000	74/10/15	75/09/10
00445	CO3 ION	CO3	MG/L	6	2.00000	19.6000	4.42719	2.21359	1.80739	11.0000	.000000	75/03/18	75/09/10
00515	RESIDUE	DISS-105	C MG/L	1	300.000					300.000	300.000	74/10/15	74/10/15
00530	RESIDUE	TOT NFLT	MG/L	1	3.00000					3.00000	3.00000	74/10/15	74/10/15
00630	NO2&NO3	N-TOTAL	MG/L	11	.106363	.003666	.060543	.569212	.018255	.190000	.020000	74/10/15	75/09/10
00665	PHOS-TOT		MG/L P	11	.030000	.001120	.033466	1.11555	.010090	.110000	.000000	74/10/15	75/09/10
00720	CYANIDE	CN-TOT	MG/L	2	.000000	.000000	.000000		.000000	.000000	.000000	74/10/15	75/07/08

STORET DATE 77/03/16

4610A2
44 00 49.0 103 49 48.0 4
CASTLE CREEK
46 7.5 DEERFIELD
T/DEERFIELD LAKE 090491
SEC RD BRDG 2.5 MI SW OF DEERFIELD DAM

/TYPA/AMBNT/STREAM

11EPALES 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	13	.017769	.000106	.010289	.579021	.002854	.040000	.005000	74/10/12	75/09/21
00615	NO2-N	TOTAL	MG/L	2	.004000	-.145E-10	.000000		.000000	.004000	.004000	74/10/12	74/11/19
00620	NO3-N	TOTAL	MG/L	2	.072000	.002048	.045255	.628540	.032000	.104000	.040000	74/10/12	74/11/19
00625	TOT KJEL	N	MG/L	13	.515384	.088494	.297479	.577198	.082506	1.30000	.100000	74/10/12	75/09/21
00630	NO2&NO3	N-TOTAL	MG/L	13	.099461	.004042	.063575	.639196	.017633	.184000	.010000	74/10/12	75/09/21
00665	PHOS-TOT		MG/L P	13	.030385	.000269	.016389	.539376	.004545	.060000	.010000	74/10/12	75/09/21
00671	PHOS-DIS	ORTHO	MG/L P	13	.012231	.000038	.006126	.500855	.001699	.025000	.005000	74/10/12	75/09/21

STORET DATE 77/03/21

03579100
35 17 08.0 086 06 20.0 2
ELK RIVER NEAR ESTILL SPRINGS.
47051 TENNESSEE
040692

/TYPA/AMBNT/STREAM
112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	6	12.9833	4.24184	2.05957	.158632	.840818	15.0000	10.5000	73/12/04	74/05/07
00061	STREAM	FLOW,	INST-CFS	7	721.141	857018	925.753	1.28373	349.902	2741.00	54.9999	73/10/26	74/05/07
00070	TURB	JKSN	JTU	6	11.2166	59.9576	7.74323	.690333	3.16116	22.0000	4.29999	73/12/04	74/05/07
00080	COLOR	PT-CO	UNITS	6	24.1666	354.164	18.8192	.778728	7.68292	59.9999	9.99999	73/12/04	74/05/07
00095	CNDUCTVY	AT 25C	MICROMHO	6	131.666	216.675	14.7199	.111797	6.00937	150.000	110.000	73/12/04	74/05/07
00300	DO		MG/L	6	10.0500	4.99106	2.23407	.222296	.912055	13.5000	7.09999	73/12/04	74/05/07
00335	COD	LOWLEVEL	MG/L	4	5.74999	9.58336	3.09570	.538384	1.54785	9.99999	3.00000	74/02/13	74/05/07
00400	PH		SU	6	7.88332	.909814	.953842	.120995	.389404	8.99999	6.59999	73/12/04	74/05/07
00410	T ALK	CACO3	MG/L	6	54.8332	53.7750	7.33314	.133735	2.99374	65.9999	45.9999	73/12/04	74/05/07
00530	RESIDUE	TOT NFLT	MG/L	6	7.16665	20.9666	4.57893	.638922	1.86934	14.0000	4.00000	73/12/04	74/05/07
00605	ORG N	N	MG/L	6	.171666	.008457	.091960	.535693	.037543	.330000	.090000	73/12/04	74/05/07
00610	NH3-N	TOTAL	MG/L	6	.043333	.000227	.015056	.347436	.006146	.060000	.020000	73/12/04	74/05/07
00630	NO2&NO3	N-TOTAL	MG/L	6	.491666	.019857	.140915	.286607	.057528	.589999	.220000	73/12/04	74/05/07
00650	T PO4	PO4	MG/L	1	.140000					.140000	.140000	73/12/04	73/12/04
00665	PHOS-TOT		MG/L P	5	.020000	.000050	.007071	.353559	.003162	.030000	.010000	74/01/29	74/05/07
00900	TOT HARD	CACO3	MG/L	6	66.1665	18.9766	4.35621	.065837	1.77841	70.9999	60.9999	73/12/04	74/05/07

STORET DATE 77/03/21

4728A1
35 17 57.0 086 05 47.0 4
ELK RIVER
47 7.5 CAPITOL HILL
O/WOODS RES 040692
ELK RIVER DAM OR BANK JUST BELO DAM

/TYPA/AMBNT/STREAM
11EPALES 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	12	.123750	.038305	.195717	1.58156	.056499	.730000	.020000	73/06/11	74/03/26
00615	NO2-N	TOTAL	MG/L	12	.012667	.000399	.019970	1.57655	.005765	.074000	.002000	73/06/11	74/03/26
00620	NO3-N	TOTAL	MG/L	12	.377416	.066539	.257952	.683468	.074464	.680000	.027000	73/06/11	74/03/26
00625	TOT KJEL	N	MG/L	12	.707499	.221384	.470515	.665039	.135826	1.54000	.200000	73/06/11	74/03/26
00630	NO2&NO3	N-TOTAL	MG/L	12	.389833	.069185	.263031	.674727	.075930	.680000	.029000	73/06/11	74/03/26
00665	PHOS-TOT		MG/L P	12	.033125	.000231	.015193	.458654	.004386	.070000	.017500	73/06/11	74/03/26
00671	PHOS-DIS	ORTHO	MG/L P	11	.014591	.000032	.005687	.389761	.001715	.023000	.005000	73/06/11	74/03/26

STORET DATE 77/03/28

01378500
40 56 52.0 074 01 34.0 2
HACKENSACK R AT NEW MILFORD NJ
34003 NEW JERSEY
013391

/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	1	4599990					4599990	4599990	74/02/12	74/02/12
00010	WATER	TEMP	CENT	12	16.5000	59.2199	7.69545	.466392	2.22148	26.0000	1.60000	73/07/11	74/07/10
00020	AIR	TEMP	CENT	3	12.5000	100.750	10.0374	.802995	5.79510	19.5000	.999999	74/04/04	74/06/03
00061	STREAM	FLOW,	INST-CFS	9	28.6666	687.249	26.2154	.914494	8.73848	94.9999	14.0000	73/07/11	74/07/10
00095	CNDUCTVY	AT 25C	MICROMHO	9	321.888	381.859	19.5412	.060708	6.51374	353.000	287.000	73/07/11	74/07/10
00300	DO		MG/L	7	7.98856	12.0703	3.47423	.434901	1.31313	11.8000	1.32000	73/07/11	74/07/10
00310	BOD	5 DAY	MG/L	9	2.62222	5.92444	2.43402	.928229	.811339	8.29999	.000000	73/07/11	74/07/10
00400	PH		SU	8	7.57499	.290737	.539200	.071182	.190636	8.29999	6.59999	73/07/11	74/07/10
00405	CO2		MG/L	1	33.0000					33.0000	33.0000	73/08/17	73/08/17
00410	T ALK	CACO3	MG/L	1	67.0000					67.0000	67.0000	73/08/17	73/08/17
00430	CO3 ALK	CACO3	MG/L	1	.000000					.000000	.000000	73/08/17	73/08/17
00440	HCO3 ION	HCO3	MG/L	1	81.9999					81.9999	81.9999	73/08/17	73/08/17
00445	CO3 ION	CO3	MG/L	1	.000000					.000000	.000000	73/08/17	73/08/17
00600	TOTAL N	N	MG/L	4	1.59500	.124100	.352278	.220864	.176139	2.10000	1.28000	73/08/17	74/05/16
00605	ORG N	N	MG/L	4	.325000	.006967	.083468	.256825	.041734	.420000	.220000	73/08/17	74/05/16
00610	NH3-N	TOTAL	MG/L	4	.289999	.032067	.179072	.617490	.089536	.549999	.150000	73/08/17	74/05/16
00615	NO2-N	TOTAL	MG/L	4	.023500	.000086	.009256	.393860	.004628	.030000	.010000	73/08/17	74/05/16
00620	NO3-N	TOTAL	MG/L	4	.955250	.194697	.441245	.461915	.220622	1.40000	.351000	73/08/17	74/05/16
00625	TOT KJEL	N	MG/L	4	.614999	.052167	.228401	.371384	.114200	.899999	.370000	73/08/17	74/05/16
00630	NO2&NO3	N-TOTAL	MG/L	3	1.16666	.043334	.208169	.178431	.120167	1.40000	.999999	73/11/27	74/05/16
00660	ORTHOPO4	PO4	MG/L	3	.062333	.000916	.030271	.485630	.017477	.090000	.030000	73/08/17	74/02/12
00665	PHOS-TOT		MG/L P	4	.063000	.000876	.029597	.469800	.014799	.100000	.030000	73/08/17	74/05/16
00671	PHOS-DIS	ORTHO	MG/L P	2	.020000	.000200	.014142	.707107	.010000	.030000	.010000	73/11/27	74/02/12
00680	T ORG C	C	MG/L	3	7.99999	76.0001	8.71780	1.08973	5.03322	18.0000	2.00000	73/08/17	74/05/16
00685	T. INORG	C	MG/L	1	20.0000					20.0000	20.0000	73/08/17	73/08/17

STORET DATE 77/03/28

3406A1
40 57 15.0 074 01 46.0 4
HACKENSACK RIVER
34 7.5 HACKENSACK
O/ORADELL RESERVOIR 013391
ORADELL AVE BRDG 0.1 MI S OF DAM

/TYPA/AMBNT/STREAM

11EPALES 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	15	.117666	.009374	.096819	.822825	.024999	.415000	.020000	73/07/21	74/07/21
00615	NO2-N	TOTAL	MG/L	15	.019467	.000095	.009738	.500263	.002514	.036000	.002000	73/07/21	74/07/21
00620	NO3-N	TOTAL	MG/L	15	1.02967	.251685	.501682	.487228	.129534	1.90000	.380000	73/07/21	74/07/21
00625	TOT KJEL	N	MG/L	14	.810000	.051785	.227563	.280942	.060819	1.40000	.500000	73/07/21	74/07/21
00630	NO2&NO3	N-TOTAL	MG/L	15	1.05427	.246863	.496853	.471279	.128287	1.90000	.410000	73/07/21	74/07/21
00665	PHOS-TOT		MG/L P	15	.050333	.000877	.029609	.588250	.007645	.125000	.005000	73/07/21	74/07/21
00671	PHOS-DIS	ORTHO	MG/L P	15	.012067	.000100	.010003	.829007	.002583	.032000	.005000	73/07/21	74/07/21

STORET DATE 77/03/21

F3159901
41 55 41.0 122 26 35.0 2
KLAMATH R BL IRON GATE DAM
06093 CALIFORNIA
KLAMATH RIVER
KLAMATH RIVER

/TYPA/AMBNT/STREAM

21CAL-1 760521 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	12	11.6667	47.1970	6.87001	.588858	1.98320	22.0000	2.00000	74/11/07	75/10/15
00011	WATER	TEMP	FAHN	1	49.0000					49.0000	49.0000	75/11/05	75/11/05
00027	COLLECT	AGENCY	CODE	13	5050.00	.000000	.000000		.000000	5050.00	5050.00	74/11/07	75/11/05
00061	STREAM	FLOW.	INST-CFS	11	2887.27	2624161	1619.93	.561058	488.426	5900.00	990.000	74/11/07	75/09/18
00076	TURB	TRBIDMTR	HACH FTU	13	5.84615	32.1410	5.66931	.969750	1.57238	21.0000	1.00000	74/11/07	75/11/05
00094	CNDUCTVY	FIELD	MICROMHO	12	176.750	357.114	18.8974	.106916	5.45522	215.000	143.000	74/11/07	75/11/05
00095	CNDUCTVY	AT 25C	MICROMHO	3	190.000	67.0000	8.18535	.043081	4.72581	199.000	183.000	74/11/07	75/05/05
00300	DO		MG/L	13	10.0692	2.56396	1.60124	.159023	.444103	12.2000	7.20000	74/11/07	75/11/05
00400	PH		SU	13	7.69999	.168376	.410336	.053290	.113807	8.40000	7.20000	74/11/07	75/11/05
00403	LAB	PH	SU	3	7.53333	.003456	.058789	.007804	.033942	7.60000	7.50000	74/11/07	75/05/05
00440	HCO3 ION	HCO3	MG/L	3	87.3333	57.3457	7.57269	.086710	4.37210	96.0000	82.0000	74/11/07	75/05/05
00445	CO3 ION	CO3	MG/L	3	.000000	.000000	.000000		.000000	.000000	.000000	74/11/07	75/05/05
00618	NO3-N	DISS	MG/L	3	.470000	.111701	.334217	.711100	.192960	.750000	.100000	74/11/07	75/05/05
00625	TOT KJEL	N	MG/L	2	.900000	.020001	.141426	.157140	.100003	1.00000	.800000	75/03/18	75/05/05
00665	PHOS-TOT		MG/L P	2	.180000	.012800	.113137	.628540	.080000	.260000	.100000	75/03/18	75/05/05
00671	PHOS-DIS	ORTHO	MG/L P	3	.123333	.003233	.056862	.461047	.032830	.170000	.060000	74/11/07	75/05/05
00900	TOT HARD	CACO3	MG/L	3	60.0000	37.0000	6.08276	.101379	3.51188	67.0000	56.0000	74/11/07	75/05/05
00930	SODIUM	NA.DISS	MG/L	3	16.3333	.333618	.577597	.035363	.333476	17.0000	16.0000	74/11/07	75/05/05
00940	CHLORIDE	CL	MG/L	3	4.13333	.013321	.115416	.027923	.066636	4.20000	4.00000	74/11/07	75/05/05

STORET DATE 77/03/21

0611A1
41 55 50.0 122 26 20.0 4
KLAMATH RIVER
06 15 COPCO
O/IRON GATE RESERVOIR 140191
BNK FRM COPCO RD .1 M BELO IRON GATE DAM

/TYPA/AMBNT/STREAM

11EPALES 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	12	.208875	.024073	.155156	.742818	.044790	.480000	.015000	74/11/16	75/11/08
00620	NO3-N	TOTAL	MG/L	2	.272000	.073728	.271529	.998269	.192000	.464000	.080000	74/11/16	74/12/07
00625	TOT KJEL	N	MG/L	12	1.73333	1.90107	1.37879	.795458	.398023	5.90000	.800000	74/11/16	75/11/08
00630	NO2&NO3	N-TOTAL	MG/L	12	.371666	.086903	.294793	.793166	.085099	.736000	.005000	74/11/16	75/11/08
00665	PHOS-TOT		MG/L P	12	.146667	.001624	.040302	.274786	.011634	.200000	.080000	74/11/16	75/11/08
00671	PHOS-DIS	ORTHO	MG/L P	12	.110000	.001772	.042091	.382643	.012151	.165000	.040000	74/11/16	75/11/08

STORET DATE 77/03/26

12301933
48 24 23.0 115 18 57.0 2
KOOTENAI RIVER BL LIBBY DAM, NEA
30053 MONTANA
130191

/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	23	9.30435	21.9259	4.68251	.563862	.976370	18.5000	2.50000	74/10/10	75/09/10
00020	AIR	TEMP	CENT	23	9.23912	96.7467	9.83599	1.06460	2.05095	26.0000	-.599E+01	74/10/10	75/09/10
00061	STREAM	FLOW,	INST-CFS	23	11232.6	.583E+08	7639.29	.680102	1592.90	27099.9	2360.00	74/10/10	75/09/10
00070	TURB	JKSN	JTU	23	3.21738	2.99603	1.73091	.537986	.360919	7.99999	.999999	74/10/10	75/09/10
00080	COLOR	PT-CO	UNITS	23	4.91304	13.1739	3.62959	.738766	.756822	15.0000	.000000	74/10/10	75/09/10
00095	CNDUCTVY	AT 25C	MICROMHO	23	252.391	2749.23	52.4331	.207745	10.9331	330.000	175.000	74/10/10	75/09/10
00300	DO		MG/L	23	14.6304	3.67312	1.91654	.130997	.399626	17.5000	11.0000	74/10/10	75/09/10
00301	DO	SATUR	PERCENT	23	132.652	28.5170	5.34014	.040257	1.11349	144.000	124.000	74/10/10	75/09/10
00310	BOD	5 DAY	MG/L	23	1.09565	.304074	.551429	.503290	.114981	2.30000	.400000	74/10/10	75/09/10
00400	PH		SU	23	8.07391	.042048	.205055	.025397	.042757	8.40000	7.70000	74/10/10	75/09/10
00405	CO2		MG/L	23	2.00434	1.12409	1.06023	.528966	.221073	4.10000	.700000	74/10/10	75/09/10
00410	T ALK	CACO3	MG/L	23	108.087	263.088	16.2200	.150064	3.38210	131.000	85.0000	74/10/10	75/09/10
00440	HCO3 ION	HCO3	MG/L	23	131.696	393.315	19.8322	.150591	4.13529	160.000	104.000	74/10/10	75/09/10
00445	CO3 ION	CO3	MG/L	23	.000000	.000000	.000000		.000000	.000000	.000000	74/10/10	75/09/10
00605	ORG N	N	MG/L	23	.149565	.009359	.096742	.646822	.020172	.380000	.000000	74/10/10	75/09/10
00610	NH3-N	TOTAL	MG/L	23	.018261	.000297	.017229	.943493	.003592	.050000	.000000	74/10/10	75/09/10
00613	NO2-N	DISS	MG/L	23	.002174	.000018	.004217	1.94001	.000879	.010000	.000000	74/10/10	75/09/10
00618	NO3-N	DISS	MG/L	23	.076521	.003578	.059819	.781726	.012473	.230000	.000000	74/10/10	75/09/10
00625	TOT KJEL	N	MG/L	23	.167826	.009291	.096388	.574332	.020098	.380000	.000000	74/10/10	75/09/10
00631	NO2&NO3	N-DISS	MG/L	23	.078695	.003585	.059872	.760803	.012484	.230000	.000000	74/10/10	75/09/10
00660	ORTHOPO4	PO4	MG/L	23	.057391	.002120	.046045	.802306	.009601	.180000	.000000	74/10/10	75/09/10
00665	PHOS-TOT		MG/L P	23	.032609	.000266	.016298	.499795	.003398	.070000	.010000	74/10/10	75/09/10
00671	PHOS-DIS	ORTHO	MG/L P	23	.019130	.000236	.015348	.802303	.003200	.060000	.000000	74/10/10	75/09/10
00680	T ORG C	C	MG/L	22	4.92272	29.0227	5.38728	1.09437	1.14857	26.0000	.000000	74/10/10	75/09/10
00900	TOT HARD	CACO3	MG/L	23	126.783	550.818	23.4695	.185116	4.89373	160.000	96.0000	74/10/10	75/09/10

STORET DATE 77/03/29

3006A1
48 22 00.0 115 19 10.0 4
KOOTENAI RIVER
30 LINCOLN CO MAP
0/KOOCANUSA RESERVOIR 130191
ST RT 37 BRDG 3.2 MI S OF LIBBY DAM

/TYPA/AMBNT/STREAM

11EPALES 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	14	.017893	.000080	.008953	.500380	.002393	.045000	.010000	74/10/06	75/09/[illegible]
00615	NO2-N	TOTAL	MG/L	1	.001000					.001000	.001000	74/10/06	74/10/[illegible]
00620	NO3-N	TOTAL	MG/L	1	.068000					.068000	.068000	74/10/06	74/10/[illegible]
00625	TOT KJEL	N	MG/L	13	.348076	.074215	.272424	.782655	.075557	.900000	.050000	74/10/06	75/09/[illegible]
00630	NO2&NO3	N-TOTAL	MG/L	14	.062000	.001275	.035704	.575870	.009542	.135000	.010000	74/10/06	75/09/[illegible]
00665	PHOS-TOT		MG/L P	14	.031286	.000298	.017269	.551979	.004615	.070000	.010000	74/10/06	75/09/[illegible]
00671	PHOS-DIS	ORTHO	MG/L P	14	.023500	.000118	.010847	.461569	.002899	.050000	.010000	74/10/06	75/09/[illegible]

STORET DATE 77/03/23

05344980
44 36 36.0 092 36 36.0 2
MISSISSIPPI R. AT LOCK & DAM 3,
27049 MINNESOTA
070592

/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER			NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010 WATER	TEMP	CENT	23	8.17391	84.7865	9.20796	1.12651	1.91999	25.0000	.000000	72/11/08	73/09/26
00060 STREAM	FLOW	CFS	15	21803.3	.345E+09	18591.1	.852676	4800.21	77999.8	8100.00	72/11/08	73/09/26
00070 TURB	JKSN	JTU	14	18.5714	293.955	17.1451	.923200	4.58223	69.9999	5.00000	72/11/08	73/09/26
00080 COLOR	PT-CO	UNITS	14	39.2857	110.991	10.5352	.268170	2.81566	50.0000	20.0000	72/11/08	73/09/26
00095 CNDUCTVY	AT 25C	MICROMHO	18	429.443	3635.29	60.2934	.140399	14.2113	499.999	317.000	72/11/08	73/09/26
00300 DO		MG/L	14	10.5428	3.10425	1.76189	.167117	.470884	12.8000	7.19999	72/11/08	73/09/26
00301 DO	SATUR	PERCENT	8	79.3886	1202.92	34.6832	.436879	12.2624	111.000	.110000	73/01/17	73/09/26
00310 BOD	5 DAY	MG/L	13	3.49615	3.03314	1.74159	.498146	.483030	6.39999	1.45000	72/11/08	73/09/26
00400 PH		SU	15	7.98666	.112723	.335743	.042038	.086688	8.69999	7.60000	72/11/08	73/09/26
00405 CO2		MG/L	11	4.76363	6.80454	2.60855	.547597	.786508	8.50000	1.10000	72/11/28	73/09/26
00410 T ALK	CACO3	MG/L	13	157.615	313.432	17.7040	.112324	4.91021	183.000	123.000	72/11/08	73/09/26
00440 HCO3 ION	HCO3	MG/L	11	196.727	961.425	31.0068	.157613	9.34892	253.000	150.000	72/11/28	73/09/26
00445 CO3 ION	CO3	MG/L	11	.000000	.000000	.000000		.000000	.000000	.000000	72/11/28	73/09/26
00550 OIL-GRSE	TOT-SXLT	MG/L	2	9.50000	144.500	12.0208	1.26535	8.50000	18.0000	1.00000	72/11/28	73/05/07
00600 TOTAL N	N	MG/L	1	3.00000					3.00000	3.00000	72/11/22	72/11/22
00605 ORG N	N	MG/L	12	1.11667	.184514	.429552	.384673	.124001	1.90000	.380000	72/11/22	73/09/26
00608 NH3-N	DISS	MG/L	4	.532500	.053625	.231572	.434876	.115786	.860000	.350000	72/11/22	73/01/17
00610 NH3-N	TOTAL	MG/L	12	.464166	.046518	.215680	.464660	.062261	.900001	.250000	72/11/22	73/09/26
00613 NO2-N	DISS	MG/L	12	.025000	.000300	.017321	.692821	.005000	.060000	.000000	72/11/22	73/09/26
00618 NO3-N	DISS	MG/L	12	2.21083	9.98688	3.16020	1.42942	.912272	12.0000	.330000	72/11/22	73/09/26
00625 TOT KJEL	N	MG/L	12	1.58583	.171323	.413912	.261006	.119486	2.50000	.730001	72/11/22	73/09/26
00631 NO2&NO3	N-DISS	MG/L	12	2.22166	9.94454	3.15350	1.41943	.910336	12.0000	.370000	72/11/22	73/09/26
00665 PHOS-TOT		MG/L P	1	.190000					.190000	.190000	72/11/22	72/11/22
00666 PHOS-DIS		MG/L P	11	.154545	.009947	.099737	.645357	.030072	.400000	.050000	72/11/28	73/09/26
00720 CYANIDE	CN-TOT	MG/L	2	.000000	.000000	.000000		.000000	.000000	.000000	72/11/28	73/05/07

STORET DATE 77/03/28

27A4A6 LS27A4A6
44 36 30.0 092 36 30.0 4
MISSISSIPPI RIVER
27 15 RED WING
T/LAKE PEPIN 070592
AT LOCK & DAM 3 5 MI NW REDWING, MN

/TYPA/AMBNT/STREAM

11EPALES 04001004
0000 CLASS 00

PARAMETER			NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610 NH3-N	TOTAL	MG/L	13	.338615	.048620	.220500	.651183	.061156	.690000	.042000	72/10/14	73/09/0-
00615 NO2-N	TOTAL	MG/L	13	.027615	.000177	.013295	.481435	.003687	.051000	.014000	72/10/14	73/09/0-
00620 NO3-N	TOTAL	MG/L	13	1.32423	.994174	.997083	.752954	.276541	3.25000	.140000	72/10/14	73/09/0-
00625 TOT KJEL	N	MG/L	13	1.88615	.261070	.510950	.270896	.141712	3.00000	1.00000	72/10/14	73/09/0-
00630 NO2&NO3	N-TOTAL	MG/L	13	1.34346	.985374	.992660	.738883	.275314	3.30000	.168000	72/10/14	73/09/0-
00665 PHOS-TOT		MG/L P	13	.209230	.001066	.032652	.156057	.009056	.250000	.155000	72/10/14	73/09/0-
00671 PHOS-DIS	ORTHO	MG/L P	13	.104692	.001614	.040180	.383789	.011144	.170000	.044000	72/10/14	73/09/0-

STORET DATE 77/03/28

05331580
44 44 48.0 092 51 08.0 2
MISSISSIPPI R BL L & D 2 AT HAST
27037 MINNESOTA
070591

/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER			NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010 WATER	TEMP	CENT	19	7.63157	66.4678	8.15278	1.06830	1.87037	26.0000	.000000	72/11/28	73/09/19
00060 STREAM	FLOW	CFS	13	15953.8	.177E+09	13338.8	.836087	3699.51	49999.9	4500.00	72/11/28	73/09/19
00070 TURB	JKSN	JTU	13	19.3077	171.398	13.0919	.678067	3.63104	50.0000	5.00000	72/11/28	73/09/19
00080 COLOR	PT-CO	UNITS	11	37.2727	81.8195	9.04541	.242682	2.72729	50.0000	20.0000	72/11/28	73/09/19
00095 CNDUCTVY	AT 25C	MICROMHO	16	525.874	5300.40	72.8038	.138443	18.2010	607.000	386.000	72/11/28	73/09/19
00300 DO		MG/L	14	10.6428	5.15963	2.27148	.213428	.607079	13.6000	6.79999	72/11/28	73/09/19
00301 DO	SATUR	PERCENT	10	92.3998	119.833	10.9468	.118472	3.46169	120.000	81.9999	72/11/30	73/09/19
00310 BOD	5 DAY	MG/L	12	3.94999	.952774	.976101	.247115	.281776	5.79999	2.00000	72/11/28	73/09/19
00400 PH		SU	13	7.92307	.085246	.291969	.036850	.080977	8.59999	7.40000	72/11/28	73/09/19
00405 CO2		MG/L	10	6.29999	19.3111	4.39444	.697531	1.38964	17.0000	2.50000	72/11/28	73/09/19
00410 T ALK	CACO3	MG/L	10	189.700	1261.58	35.5187	.187236	11.2320	233.000	131.000	72/11/28	73/09/19
00440 HCO3 ION	HCO3	MG/L	10	231.300	1866.69	43.2052	.186793	13.6627	284.000	160.000	72/11/28	73/09/19
00445 CO3 ION	CO3	MG/L	10	.000000	.000000	.000000		.000000	.000000	.000000	72/11/28	73/09/19
00550 OIL-GRSE	TOT-SXLT	MG/L	2	16.5000	480.500	21.9203	1.32850	15.5000	32.0000	1.00000	72/11/28	73/05/07
00605 ORG N	N	MG/L	10	1.19600	.134049	.366127	.306126	.115780	1.80000	.650001	72/11/28	73/09/19
00608 NH3-N	DISS	MG/L	3	.883333	.085834	.292974	.331669	.169149	1.10000	.550000	72/11/28	73/01/17
00610 NH3-N	TOTAL	MG/L ⟷	10	.693000	.153912	.392316	.566113	.124061	1.20000	.110000	72/11/28	73/09/19
00613 NO2-N	DISS	MG/L	10	.026000	.000293	.017127	.658731	.005416	.050000	.000000	72/11/28	73/09/19
00618 NO3-N	DISS	MG/L	10	2.46300	5.73744	2.39529	.972512	.757459	8.60000	.170000	72/11/28	73/09/19
00625 TOT KJFL	N	MG/L ⟷	10	1.89000	.165446	.406750	.215212	.128626	2.60000	1.20000	72/11/28	73/09/19
00631 NO2&NO3	N-DISS	MG/L	10	2.47200	5.69517	2.38646	.965396	.754664	8.60000	.210000	72/11/28	73/09/19
00666 PHOS-DIS		MG/L P	10	.199000	.011210	.105878	.532052	.033482	.340000	.060000	72/11/28	73/09/19
00720 CYANIDE	CN-TOT	MG/L	2	.010000	.000200	.014142	1.41421	.010000	.020000	.000000	72/11/28	73/05/07
00900 TOT HARD	CACO3	MG/L	10	250.000	1711.11	41.3656	.165462	13.0809	300.000	180.000	72/11/28	73/09/19
00902 NC HARD	CACO3	MG/L	10	59.6000	1283.60	35.8274	.601131	11.3296	130.000	15.0000	72/11/28	73/09/19

STORET DATE 77/03/28

27A4A4 LS27A4A4
44 45 00.0 092 51 00.0 4
MISSISSIPPI RIVER
27 15 HASTINGS
T/LAKE PEPIN 070591
US 61 BRDG N HASTINGS ABOVESTP
11EPALES 04001004
0000 CLASS 00

/TYPA/AMBNT/STREAM

PARAMETER			NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610 NH3-N	TOTAL	MG/L ⟷	11	.337090	.054846	.234192	.694746	.070612	.740000	.032000	72/10/14	73/09/22
00615 NO2-N	TOTAL	MG/L	11	.024955	.000227	.015051	.603124	.004538	.054000	.004000	72/10/14	73/09/22
00620 NO3-N	TOTAL	MG/L	11	1.78245	1.04386	1.02169	.573196	.308052	2.80000	.231000	72/10/14	73/09/22
00625 TOT KJFL	N	MG/L ⟷	11	1.77636	.078006	.279295	.157229	.084211	2.10000	1.26000	72/10/14	73/09/22
00630 NO2&NO3	N-TOTAL	MG/L	11	1.80109	1.04171	1.02064	.566682	.307736	2.90000	.260000	72/10/14	73/09/22
00665 PHOS-TOT		MG/L P	11	.254545	.004647	.068172	.267817	.020555	.370000	.170000	72/10/14	73/09/22
00671 PHOS-DIS	ORTHO	MG/L P	11	.135909	.004290	.065501	.481945	.019749	.250000	.034000	72/10/14	73/09/22

STORET DATE 77/03/21

06862000
38 47 30.0 099 43 20.0 2
SMOKY HILL R AT CEDAR BLUFF DAM.
20195 KANSAS

/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00010	WATER	TEMP	CENT	16	15.9375	78.2286	8.84469	.554962	2.21117	28.0000	2.50000	74/10/16	75/09/16
00027	COLLECT	AGENCY	CODE	12	1028.00	3.09091	1.75810	.001710	.507519	1028.00	1028.00	74/10/16	75/09/16
00028	ANALYZE	AGENCY	CODE	12	9719.96	372.364	19.2967	.001985	5.57048	9719.98	9719.98	74/10/16	75/09/16
00061	STREAM	FLOW.	INST-CFS	12	2.19966	3.85236	1.96274	.892293	.566595	7.89999	.196000	74/10/16	75/09/16
00070	TURB	JKSN	JTU	16	3.37499	8.91668	2.98608	.884767	.746520	9.99999	.999999	74/10/16	75/09/16
00095	CNDUCTVY	AT 25C	MICROMHO	16	1186.25	5624.53	74.9969	.063222	18.7492	1390.00	1050.00	74/10/16	75/09/16
00400	PH		SU	16	7.78124	.061621	.248236	.031902	.062059	8.29999	7.29999	74/10/16	75/09/16
00405	CO2		MG/L	12	5.09166	2.68810	1.63954	.322005	.473295	8.00000	2.80000	74/10/16	75/09/16
00410	T ALK	CACO3	MG/L	12	118.250	186.386	13.6523	.115453	3.94109	139.000	82.0000	74/10/16	75/09/16
00440	HCO3 ION	HCO3	MG/L	12	144.166	281.057	16.7647	.116287	4.83956	170.000	99.9998	74/10/16	75/09/16
00445	CO3 ION	CO3	MG/L	12	.000000	.000000	.000000		.000000	.000000	.000000	74/10/16	75/09/16
00618	NO3-N	DISS	MG/L	12	.047500	.000420	.020505	.431685	.005919	.090000	.020000	74/10/16	75/09/16
00650	T PO4	PO4	MG/L	12	.139999	.003236	.056890	.406356	.016423	.280000	.090000	74/10/16	75/09/16
00665	PHOS-TOT		MG/L P ⟵⟶	12	.046667	.000297	.017233	.369275	.004975	.090000	.030000	74/10/16	75/09/16
00900	TOT HARD	CACO3	MG/L	12	530.832	591.000	24.3105	.045797	7.01783	570.000	469.999	74/10/16	75/09/16
00902	NC HARD	CACO3	MG/L	12	411.666	197.000	14.0357	.034095	4.05175	430.000	380.000	74/10/16	75/09/16

STORET DATE 77/03/21

2001A1
38 47 30.0 099 43 20.0 4
SMOKY HILL RIVER
20 TREGO CO HWY MAP
O/CEDAR BLUFF RESERVOIR
BANK SAMPLE NEAR BASE OF DAM

/TYPA/AMBNT/STREAM

11EPALES 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	14	.037464	.000424	.020599	.549835	.005505	.090000	.020000	74/10/13	75/09/1-
00615	NO2-N	TOTAL	MG/L	1	.004000					.004000	.004000	74/10/13	74/10/1:
00620	NO3-N	TOTAL	MG/L	1	.008000					.008000	.008000	74/10/13	74/10/1:
00625	TOT KJEL	N	MG/L	14	1.33571	1.22440	1.10652	.828415	.295731	4.40000	.450000	74/10/13	75/09/.-
00630	NO2&NO3	N-TOTAL	MG/L	14	.042786	.015656	.125919	2.94302	.033653	.480000	.005000	74/10/13	75/09/.-
00665	PHOS-TOT		MG/L P ⟵⟶	14	.039464	.000623	.024965	.632597	.006672	.100000	.010000	74/10/13	75/09/.-
00671	PHOS-DIS	ORTHO	MG/L P	14	.007607	.000007	.002603	.342192	.000696	.012500	.005000	74/10/13	75/09/1-

STORET DATE 77/03/28

01431670
41 22 04.0 075 19 10.0 2
WALLENPAUPACK CREEK AT LEDGEDALE
42103 PENNSYLVANIA
020391

/TYPA/AMBNT/STREAM

112WRD 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00008	LAB	IDENT.	NUMBER	8	1404916	.156E+14	3957814	2.81712	1399298	.111E+08	.849999	73/06/20	74/04/17
00010	WATER	TEMP	CENT	12	10.8333	90.1512	9.49480	.876445	2.74091	25.0000	.000000	73/06/20	74/04/17
00020	AIR	TEMP	CENT	12	14.5833	76.9922	8.77452	.601682	2.53298	25.0000	.999999	73/06/20	74/04/17
00060	STREAM	FLOW	CFS	11	368.417	124294	352.554	.956941	106.299	1200.00	51.9999	73/07/25	74/04/17
00061	STREAM	FLOW.	INST-CFS	11	368.454	124272	352.523	.956763	106.290	1200.00	51.9999	73/07/25	74/04/17
00065	STREAM	STAGE	FEET	1	15.1000					15.1000	15.1000	73/06/20	73/06/20
00095	CNDUCTVY	AT 25C	MICROMHO	12	65.1665	82.7113	9.09457	.139559	2.62538	84.9999	52.9999	73/06/20	74/04/17
00300	DO		MG/L	11	10.3818	5.24372	2.28992	.220570	.690436	14.2000	6.79999	73/06/20	74/04/17
00301	DO	SATUR	PERCENT	11	94.2725	48.2250	6.94442	.073663	2.09382	103.000	77.9999	73/06/20	74/04/17
00310	BOD	5 DAY	MG/L	9	2.50000	8.63999	2.93939	1.17576	.979795	9.69999	.000000	73/06/20	74/04/17
00400	PH		SU	11	6.73635	.160571	.400713	.059485	.120820	7.49999	6.19999	73/06/20	74/04/17
00405	CO2		MG/L	11	4.80909	9.82692	3.13479	.651848	.945175	11.0000	.700000	73/06/20	74/04/17
00410	T ALK	CACO3	MG/L	11	11.4545	16.6727	4.08323	.356472	1.23114	20.0000	6.00000	73/06/20	74/04/17
00440	HCO3 ION	HCO3	MG/L	11	13.8182	23.5636	4.85424	.351294	1.46361	24.0000	6.99999	73/06/20	74/04/17
00445	CO3 ION	CO3	MG/L	11	.000000	.000000	.000000		.000000	.000000	.000000	73/06/20	74/04/17
00500	RESIDUE	TOTAL	MG/L	11	52.9998	75.8121	8.70701	.164284	2.62526	69.9999	40.9999	73/06/20	74/04/17
00530	RESIDUE	TOT NFLT	MG/L	11	6.54544	19.0727	4.36723	.667217	1.31677	18.0000	2.00000	73/06/20	74/04/17
00600	TOTAL N	N	MG/L	6	.443333	.031307	.176938	.399108	.072235	.720000	.220000	73/10/15	74/03/21
00605	ORG N	N	MG/L	10	.185000	.024672	.157074	.849052	.049671	.420000	.000000	73/06/20	74/03/21
00608	NH3-N	DISS	MG/L	4	.062500	.002692	.051881	.830101	.025941	.140000	.030000	73/06/20	73/09/18
00610	NH3-N	TOTAL	MG/L	6	.078333	.001257	.035449	.452547	.014472	.140000	.050000	73/10/15	74/03/21
00613	NO2-N	DISS	MG/L	4	.003250	.000002	.001500	.461538	.000750	.005000	.002000	73/06/20	73/09/18
00615	NO2-N	TOTAL	MG/L	7	.004000	.000019	.004359	1.08973	.001648	.010000	.000000	73/10/15	74/04/17
00618	NO3-N	DISS	MG/L	4	.047500	.000892	.029861	.628649	.014930	.080000	.010000	73/06/20	73/09/18
00620	NO3-N	TOTAL	MG/L	7	.278571	.021014	.144963	.520382	.054791	.470000	.030000	73/10/15	74/04/17
00625	TOT KJEL	N	MG/L	9	.242222	.020420	.142897	.589944	.047632	.459999	.100000	73/07/25	74/03/21
00630	NO2&NO3	N-TOTAL	MG/L	7	.281428	.021214	.145652	.517546	.055051	.469999	.030000	73/10/15	74/04/17
00631	NO2&NO3	N-DISS	MG/L	4	.050000	.000867	.029439	.588785	.014720	.080000	.010000	73/06/20	73/09/18
00660	ORTHOPO4	PO4	MG/L	11	.016364	.000225	.015015	.917593	.004527	.040000	.000000	73/06/20	74/04/17
00665	PHOS-TOT		MG/L P	11	.017636	.000069	.008298	.470502	.002502	.030000	.007000	73/06/20	74/04/17
00671	PHOS-DIS	ORTHO	MG/L P	11	.005545	.000022	.004719	.851039	.001423	.012000	.000000	73/06/20	74/04/17

4229A2
41 22 02.0 075 19 14.0 4
WALLENPAUPACK CREEK
42 7.5 NEWFOUNDLAND
I/LAKE WALLENPAUPACK 020391
AT BANK .3 MI E OF LEDGEDALE
11EPALES 04001004
0000 CLASS 00

/TYPA/AMBNT/STREAM

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	12	.063167	.003524	.059364	.939807	.017137	.189000	.010000	73/05/19	74/04/23
00615	NO2-N	TOTAL	MG/L	12	.001333	.242E-06	.000492	.369277	.000142	.002000	.001000	73/05/19	74/04/23
00620	NO3-N	TOTAL	MG/L	12	.176250	.017949	.133974	.760136	.038675	.368000	.011000	73/05/19	74/04/23
00625	TOT KJEL	N	MG/L	12	.652916	.110311	.332131	.508689	.095878	1.30000	.200000	73/05/19	74/04/23
00630	NO2&NO3	N-TOTAL	MG/L	12	.177416	.017770	.133304	.751362	.038482	.368000	.012000	73/05/19	74/04/23
00665	PHOS-TOT		MG/L P	11	.024864	.000065	.008075	.324771	.002435	.040000	.010000	73/05/19	74/04/23
00671	PHOS-DIS	ORTHO	MG/L P	12	.006417	.000003	.001832	.285499	.000529	.010000	.005000	73/05/19	74/04/23

In 1971, the Illinois EPA collected from 2 to 7 samples at nine comparable sampling sites on seven streams from which the NES obtained from 9 to 14 samples during the period of June, 1973 through May, 1974. There is quite good agreement between IL EPA and NES total phosphorus data considering the difference in times of collection (excluding one obviously different data pair, the mean of all IL EPA TP data is 155 μg/l and the mean of all NES data is 157 μg/l; the coefficient of rank correlation is 0.78, n = 8).

In 1973-74, the Wisconsin DNR collected 3 or 4 samples at 11 stream sites from which the NES collected from 11 to 14 samples during the period of September, 1972 through September, 1973 (28 of the 38 DNR samples were taken after NES sampling was completed). There is very good agreement between DNR and NES total phosphorus data (excluding one obviously different data pair, the mean of all DNR TP data is 122 μg/l and the mean of NES data is 134 μg/l; the coefficient of rank correlation is 0.88, n = 10). However, the agreement between DNR and NES total nitrogen data is not as good (excluding two obviously different data pairs, the mean of all DNR data is 1,643 μg/l and the mean of all NES data is 1,816 μg/l; the coefficient of rank correlation is 0.65, n = 9).

Finally, data obtained at several of the NES analytical quality control stations were evaluated. Control stations were those at which two separate samples were taken, usually at the same time by the same National Guard sampling team, but a few such stations were sampled by different teams on different days. For the most part, one of the sample pairs was an inlet sample for one water body and the other sample was an outlet sample for another water body, so the two samples had different identifiers (STORET code) and could not readily be detected as control samples by the analysts at CERL.

One example of a control station on the Wichita River in Texas is shown on the following page. It will be noted that though the sampling locations are identical, one set is identified as the inlet of Lake Diversion, and the other set is identified as the outlet of Lake Kemp. Also it will be noted that the data essentially are identical considering the precision limits of the analytical methods and the extra "outlet" sample.

Comparisons of six other sets of analytical quality control data are on file at CERL; and in all cases, the data are as nearly identical as in the example shown.

STORET DATE 77/04/11

4812A2
33 45 37.0 099 08 30.0 4
WICHITA RIVER
48 7.5 NE LK KEMP
T/LAKE DIVERSION 101591
HWY 183/283 BRDG BELO LAKE KEMP DAM
/TYPA/AMBNT/STREAM 11EPALES 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	7	.035714	.000395	.019881	.556658	.007514	.075000	.020000	74/09/07	75/04/22
00615	NO2-N	TOTAL	MG/L	2	.009500	.000084	.009192	.967619	.006500	.016000	.003000	74/09/07	74/10/31
00620	NO3-N	TOTAL	MG/L	3	.174667	.049669	.222866	1.27595	.128672	.432000	.044000	74/09/07	74/11/16
00625	TOT KJEL	N	MG/L	7	.664285	.063929	.252842	.380622	.095565	1.20000	.400000	74/09/07	75/04/22
00630	NO2&NO3	N-TOTAL	MG/L	7	.038143	.000588	.024259	.635991	.009169	.080000	.005000	74/09/07	75/04/22
00665	PHOS-TOT		MG/L P	6	.031667	.000057	.007528	.237721	.003073	.040000	.020000	74/09/07	75/04/22
00671	PHOS-DIS	ORTHO	MG/L P	7	.008571	.000031	.005563	.649073	.002103	.020000	.005000	74/09/07	75/04/22

STORET DATE 77/04/13

4816A1
33 45 37.0 099 08 30.0 4
WICHITA RIVER
48 7.5 NE LAKE KEMP
O/LAKE KEMP 101591
183/283 BRDG BELO DAM
/TYPA/AMBNT/STREAM 11EPALES 04001004
0000 CLASS 00

PARAMETER				NUMBER	MEAN	VARIANCE	STAN DEV	COEF VAR	STAND ER	MAXIMUM	MINIMUM	BEG DATE	END DATE
00610	NH3-N	TOTAL	MG/L	8	.046250	.000741	.027223	.586598	.009625	.085000	.020000	74/09/07	75/[illegible]/22
00615	NO2-N	TOTAL	MG/L	3	.008000	.000048	.006928	.866024	.004000	.016000	.004000	74/09/07	74/[illegible]/31
00620	NO3-N	TOTAL	MG/L	3	.184000	.065856	.256624	1.39470	.148162	.480000	.024000	74/09/07	74/[illegible]/31
00625	TOT KJEL	N	MG/L	8	.687500	.104822	.323762	.470926	.114467	1.40000	.350000	74/09/07	75/[illegible]/22
00630	NO2&NO3	N-TOTAL	MG/L	8	.039500	.000490	.022142	.560567	.007829	.075000	.005000	74/09/07	75/[illegible]/22
00665	PHOS-TOT		MG/L P	7	.034286	.000095	.009759	.284639	.003689	.050000	.020000	74/09/07	75/[illegible]/22
00671	PHOS-DIS	ORTHO	MG/L P	8	.007500	.000029	.005345	.712696	.001890	.020000	.005000	74/09/07	75/[illegible]/22

E. Tributary Nutrient Loads -

In our evaluation of nutrient loads in streams, we have restricted comparisons to loads reported by others which we assume were determined by direct measurement. Unfortunately, with only one exception, the NES working papers are the only reports we have reviewed in which the method of calculation of loadings is stated or at least referenced. Because of this and a general uncertainty as to the sources of flow data (U.S.G.S. or independently gaged, metered, or estimated in one or more ways), we are by far more dubious about the comparability of stream nutrient loads (and wastewater treatment plant effluent loads; section F, below) than any of the other measurements made during the Survey.

Considering the good agreement between the NES stream nutrient concentrations and those of others demonstrated in the preceding section, it would be expected that equally good agreement can be shown for nutrient loads provided sampling times are comparable, the frequency of sampling is similar, the flows essentially are identical, and the same method of calculation is used. However, in one case (Campbell and Dean, 1976), using the concentrations and flows given, we calculated a total phosphorus load for one stream that is 63% less than the load reported; but for another stream, our calculated TP load is 54% less than the reported load. Obviously, some unknown weighting factor was incorporated in the calculation of the reported loads. It is equally obvious that if some of the raw data had not been included in that report, the weighting factor would not have been detected, and a spurious comparison of nutrient loads would have resulted.

It should be noted that flows are equally as important as nutrient concentrations in the determination of nutrient loads, so some differences in loadings would be expected because of flow differences. For example, the U.S. Geological Survey submitted limits of accuracy of the gaged and estimated flows they provided for the NES-sampled tributaries, and the limits of accuracy of gaged flows of tributaries sampled in 1972 varied from ±5% to ±15% (one extreme of ±50%); i.e., as much as 30% difference in calculated nutrient loads could have resulted solely from the limits of accuracy of the gaged flows, and the limits of accuracy of flows measured or estimated by others are not likely to be as good as those attained by U.S.G.S.

Because of the scarcity of reported nutrient loadings and the uncertainties noted above, data comparisons necessarily will be less extensive than in other sections of this report.

In the following table, three years of loading data reported by Weiss and Moore (1975) for three gaged tributaries and two years of data for the gaged outlet of John H. Kerr Reservoir, VA and NC, were compared with NES loadings. The Weiss-Moore loads were reported as mean daily loads (in kg) based on monthly samples and were extrapolated to yearly loads; the NES loads were calculated using mean annual concentrations and mean annual flows.

River	Data Source & Period	No. Samples	Mean Flow (m^3/sec)	TP Load (kg/yr)	TN Load (kg/yr)
	W-M, 7/72-3/73	8	98.780	221,920	1,598,700
Roanoke	W-M, 4/73-3/74	11	104.982	191,260	2,005,675
	W-M, 4/74-3/75	12	77.172	209,510	1,185,520
	NES, 7/73-6/74	15	82.460	205,435	3,123,150
	W-M, 7/72-3/73	8	15.916	18,615	240,535
Banister	W-M, 4/73-3/74	11	15.463	23,360	304,045
	W-M, 4/74-3/75	12	17.417	26,645	321,200
	NES, 7/73-6/74	14	14.800	32,205	578,750
	W-M, 7/72-3/73	8	78.418	279,225	1,451,605
Dan	W-M, 4/73-3/74	11	83.091	428,510	2,301,690
	W-M, 4/74-3/75	12	79.381	354,050	2,106,050
	NES, 7/73-6/74	13	68.100	466,030	2,920,740
	W-M, 9/73-3/74	6	210.276	201,845	4,200,785
Outlet	W-M, 4/74-3/75	12	250.887	377,045	4,026,680
(Roanoke)	NES, 7/73-6/74	15	197.800	149,710	6,699,420

Considering the differences in sampling periods, flows, numbers of samples, and methods of calculation, the NES data compare quite well (note the between-year differences in the Weiss-Moore loads).

Another example of between-year loading differences is shown in the following table where the NES data are compared with data reported by Wright and Soltero (1973) for two tributaries and the outlet of Yellowtail Reservoir, MT and WY. The nutrient loads in both cases were calculated using mean annual concentrations and mean annual flows. Again considering differences, particularly sampling times, the Wright-Soltero 1969 loads compare quite well with the NES loads.

River	Data Source & Period	No. Samples	Mean Flow (m^3/sec)	TP Load (kg/yr)	TN Load (kg/yr)
	W-S, 1/68-12/68	19	72.384	1,524,845	3,145,565
Bighorn	W-S, 1/69-12/69	27	72.414	589,180	3,459,725
	NES, 10/74-9/75	10	64.660	656,595	3,085,185
	W-S, 1/68-12/68	19	28.388	189,790	1,540,715
Shoshone	W-S, 1/69-12/69	27	31.094	201,020	1,746,415
	NES, 10/74-9/75	13	29.480	383,960	1,934,665
	W-S, 1/68-12/68	19	117.916	122,715	4,741,215
Outlet	W-S, 1/69-12/69	27	94.953	86,840	3,455,580
(Bighorn)	NES, 10/74-9/75	8	100.780	66,740	5,075,580

Wright et al. (1974) reported total phosphorus loads in the Missouri River inlet of Canyon Ferry Reservoir, MT, for four months of sampling (May-September) in 1971 and 1972. The reported loads were extrapolated to a full year and are compared to the NES total phosphorus load measured during the period of 10/74 through 8/75 (calculated using mean annual concentrations and flows).

Data Source & Year	No. Samples	TP Load (kg/yr)
W - 1971	16	405,510
W - 1972	16	347,030
NES - 1974-75	13	370,080

Hydroscience, Incorporated (Anonymous, 1974), reported nutrient and flow data obtained by the U.S. Geological Survey at a station on the West Branch of the Delaware River, NY, during the period of 05/73 through 04/74. The same station was sampled by the NES during the period of 11/72 through 04/73. The nutrient loads compared below were calculated using the reported mean annual concentrations and flows.

No. Samples		Total P (kg/yr)		Total N (kg/yr)	
U.S.G.S	NES	U.S.G.S.	NES	U.S.G.S.	NES
11	14	82,405	81,235	498,110	726,055

In a U.S. Geological Survey publication, Goolsby and McPherson (1970) reported nutrient concentrations and flows for the St. Johns River outlet of Lake Poinsett, FL, obtained during the period of 07/69 through 07/70. The same station was sampled by the NES during the period of 03/73 through 02/74. The nutrient loads compared below were calculated using the means of the reported concentrations and flows.

No. Samples		Total P (kg/yr)		Total N (kg/yr)	
U.S.G.S.	NES	U.S.G.S.	NES	U.S.G.S.	NES
6	11	82,540	75,045	1,907,445	1,801,035

Agena (1975) reported nutrient and flow data obtained at a station on the South Fork Chariton River, IA, during the period of 03/71 through 11/72. The same station was sampled by the NES during the period of 08/74 through 07/75. The nutrient loads shown below were calculated using the means of the reported concentrations and flows.

No. Samples		Total P (kg/yr)		Total N (kg/yr)	
A	NES	A	NES	A	NES
25	14	17,195	20,150	217,370	176,915

Brye (1970) reported the sums of all total phosphorus and total nitrogen inputs to and the loads in the outflows of two TVA reservoirs in Tennessee based on data obtained during calendar year 1968. In the next table, the TVA loads are compared with NES loads that are based on data obtained during the period of 04/73 through 03/74.

Cherokee Reservoir

Agency	Total P (kg/yr)		Total N (kg/yr)	
	Inputs	Outflow	Inputs	Outflow
TVA	426,305	131,520	11,682,540	8,027,210
NES	469,800	174,735	6,826,440	6,402,390

Douglas Reservoir

TVA	789,155	190,475	6,598,640	4,716,555
NES	682,370	286,690	9,126,655	7,702,060

Overall, the NES loadings compare quite well to those reported by others considering variables such as flows, times of sampling, and methods of calculation.

A further appraisal of the NES nutrient loadings involves the apparent loss of nitrogen, phosphorus (less frequently), or both nutrients (rarely) from some of the water bodies surveyed. Usually, but not invariably, the apparent nitrogen losses occurred at water bodies with mean hydraulic retention times of less than 40 days, and losses of both nitrogen and phosphorus occurred at water bodies with retention times of less than ten days.

While nitrogen washout could occur as a result of nitrogen fixation in the water bodies, and phosphorus washout would be possible, for example, if point-source inputs had been reduced or eliminated in the recent past, the limits of accuracy of flow measurements noted above could have resulted in many of the nutrient imbalances; e.g., at 90% of the water bodies surveyed in 1972 where nutrient loss occurred, the loss can be accounted for by the accuracy of the flow data (i.e., the percent loss is less than the range of the accuracy limits of flows). However, the magnitude of loss at the six remaining water bodies indicates other factors were involved, but the probable causes of the losses can be identified with some degree of confidence for five of the six.

In regard to nitrogen losses, it is noted that such losses occurred at Shagawa Lake, MN, in three of the six years for which loadings were reported by Malueg et al. (1975), although tributary sampling there was much more intensive than was possible during the Survey (loads in the Shagawa and Burntside rivers were determined from weekly nutrient samples and daily flows; loads in the creeks, where no relationship could be established for nutrient concentrations vs. flow, were calculated using mean nutrient concentrations for a month and the total flow for that month). Shagawa Lake has a mean hydraulic retention time of nine months.

Further consideration of the NES tributary phosphorus concentrations, loads, and losses involves sampling frequency, particularly with respect to smaller streams. Some recent studies have shown that a large proportion of the phosphorus export of smaller watersheds is associated with short-term periods of peak runoff; and in other studies reviewed, frequency of sampling and continuous vs. discontinuous flow measurements for the determination of phosphorus loads in small and medium-sized streams were evaluated.

Treunert et al. (1974) used total phosphorus concentrations obtained from sampling a small stream (mean flow of about 1.1 m^3/sec) described as draining an agricultural area with scattered settlements (presumably, there are no point sources in the drainage since the authors note the stream does not show distinct daily variations of nitrogen and phosphorus concentrations, and no mention of point sources is made anywhere in their report).

The stream was sampled approximately every three days in 1968 (111 samples in 366 days) with continuous flow measurements during that period to compare various sampling frequencies and continuous vs. discontinuous total daily flow measurements. To obtain a base or reference load, 266 fictive TP concentrations were added to the data base by interpolating concentration values for the days no samples were taken; the daily measured or interpolated concentrations were then multiplied by the respective total daily flows, and the sum of the daily loads for the year was used as the reference total phosphorus annual load. The sum of the total daily flows provided the reference annual total flow.

The authors then simulated sampling using intervals of from one day to 29 days; varied the starting day for sampling intervals of three days and longer to provide a number of sampling sequences (e.g., with a seven-day interval, varying the starting day from the first to the second day, and so on, provided seven different sampling series for the year); and compared the simulated annual TP loads and annual flows with the reference load and the reference flow.

From the results of their comparisons, the authors concluded that with continuous flow measurements, the sampling frequency for small streams could be extended to 28 days if a mean of the differences of annual loads from a reference load (the sum of daily concentrations X total daily flows) of 20% is acceptable as well as a maximum difference of about 40%. They also concluded that if the maximum difference is not to exceed 20%, a sampling frequency of from 14 to 21 days is necessary.

A similar study was conducted by Unger (1970) on a larger stream (mean flow of 18.6 m^3/sec) with point sources in the drainage. He collected daily 24-hour composited samples (subsamples every 30 seconds), measured flows continuously, and determined daily nutrient loads for a one-year period. In this way, he determined quite accurate total phosphorus and other nutrient loads.

Unger then simulated sampling every third, fifth, tenth, and twentieth day and added another series for each of the three shortest intervals by offsetting the beginning day by one day (e.g., tenth day and tenth day + 1). Deviations from the annual total phosphorus load ranged from -13.8% (tenth day + 1) to +13.9% (third day). The deviation of twentieth-day sampling was -8.2%, and no particular relationship between sampling frequency and deviation from the reference load was evident.

On the basis of these results, Unger concluded that reasonably accurate nutrient loads (margin of error of less than 10%) can be determined by sampling from ten to 20 times per year providing samples are taken at all characteristic stream flows, especially during high flows.

Johnson et al. (1976) studied phosphorus losses from the Fall Creek (NY) watershed during the period of September, 1972, and April, 1974. This study is of particular interest since their Fall Creek sampling site 1 was sampled 13 times by the NES during the period November, 1972, through October, 1973. The stream has a mean flow of about 5 m^3/sec (Anonymous, 1973).

The authors sampled several times a day during most high flows and at three- to 20-day intervals during low flow periods; flows were measured bihourly at a nearby U.S. Geological Survey gaging station. Over 600 samples were collected at their site 1 during the 20-month study period, and analyses of dissolved molybdate reactive phosphorus (DMRP), dissolved unreactive P, solid phase P, and suspended solids were performed. From this rather intensive sampling program, the authors determined that losses of phosphorus from the watershed per unit of time varied considerably, and 75% of the loss occurred during highest flows which occurred 10% of the time. They also concluded that if exports are calculated using total discharge and mean concentrations in samples taken at random or on a fixed schedule, errors would range from slight in the case of dissolved unreactive P (concentrations not flow-related) to severe in the case of solid phase P and suspended solids (concentrations directly related to flows).

Although their study period overlapped the NES sampling period, only six months of their data on parameters common to both studies (DMRP and flows) can be compared. For months with low discharge rates (September and October, 1972, and May through November, 1973), the authors lumped the data and presented only the totals of the loads and flows for those nine months in their report (Table 3, page 152). Also for those months, their DMRP and suspended solids loads were calculated by a method different from that used in the remainder of their study (i.e., the mean of measured concentrations for each of the nine months times the sum of the bihourly discharges for those months).

The DMRP exports of the authors for other than low-flow months were calculated using an equation which included a factor for conversion of instantaneous flux to kg per two hours, the instantaneous bihourly discharge rate, monthly coefficients obtained from regression equations of DMRP on discharge and rate of change of discharge, and the bihourly rate of change of discharge. For the six comparable months, the sum of the authors' DMRP loads differs by 285 kg (7.2%) from the NES load calculated using mean daily flows and concentrations. Considering the different methods of calculation and differences in analytical techniques (e.g., analytical precision, sample preservation, centrifugation vs NES filtration, and stannous chloride vs NES ascorbic acid reduction), the two loads are quite comparable (3,675 kg vs NES 3,960 kg).

The flow data reported by the authors are almost exactly the same as the mean monthly flows the U.S. Geological Survey provided the NES (three of the six are identical, and overall there is a difference of only 1%). This is not unexpected since the gaging station at which both sets of flow data were obtained is equipped with a water-stage recorder that provides a continuous graph of the fluctuations of water surface elevation (Anonymous, 1973).

Welch (1977) conducted an even more intensive sampling program than that used in the Fall Creek study cited above to determine nutrient loads in Issaquah Creek, WA (mean flow of about 4 m^3/sec). By continuous monitoring of the stream during water year 1973 (over 1,000 samples with continuous flow measurement) he found that daily observations were necessary to avoid missing from 25 to 30 percent of the annual total phosphorus export that occurred in four-day periods of peak runoff in each of two consecutive years.

On the basis of the results of the studies cited above, it appears that intensive sampling may not be necessary to determine phosphorus loads in larger streams with acceptable accuracy (ref. Unger, 1970) but that more intensive sampling than was possible during the Survey may be necessary for accurate measurement of phosphorus loads in smaller streams. However, note that while Johnson et al. (1976) found that 75% of the phosphorus export of Fall Creek occurred in 10% of the time, Welch (1977) found that 25 to 30% of the Issaquah Creek export occurred in four days, and Malueg et al. (1975) reported that no relationship could be established between nutrient concentrations and flows in four small tributaries of Shagawa Lake, MN (mean flows of from 0.02 to 0.25 m^3/sec). These differing findings indicate that it would be necessary to make determinations of sampling frequencies needed on a stream-by-stream basis. Given the scope of the Survey, that would have been a virtually impossible undertaking and probably would have exhausted the total resources of the Survey in just one of the larger states such as Minnesota where 89% of the streams sampled had flows of less than 5 m^3/sec.

At this point in time, there may not be any sure way of determining the degree of error, if any, in the nutrient loads measured by the NES. Ideally, one could compare NES loads with those determined by intensive sampling during a comparable period of time, as in the Fall Creek study, with an assumption of no error in the reference study. However, as far as is known, Fall Creek is the only case in kind, and even there the comparable data are so limited as to make any conclusion somewhat debatable.

Lacking comparable loading studies based on intensive sampling, we reviewed the data obtained in 1972 on 80 lakes and 167 tributaries in the states of Michigan and Minnesota to determine what the consequences of a sizable error in stream nutrient loadings might have been in terms of our assessment of nutrient controllability, the primary end-product of the Survey effort. Assuming the improbable case that <u>all</u> NES phosphorus loads in the 167 tributaries were in error by plus or minus 30% , we found that our assessment would be changed for only 12 of the 80 cases (15%).

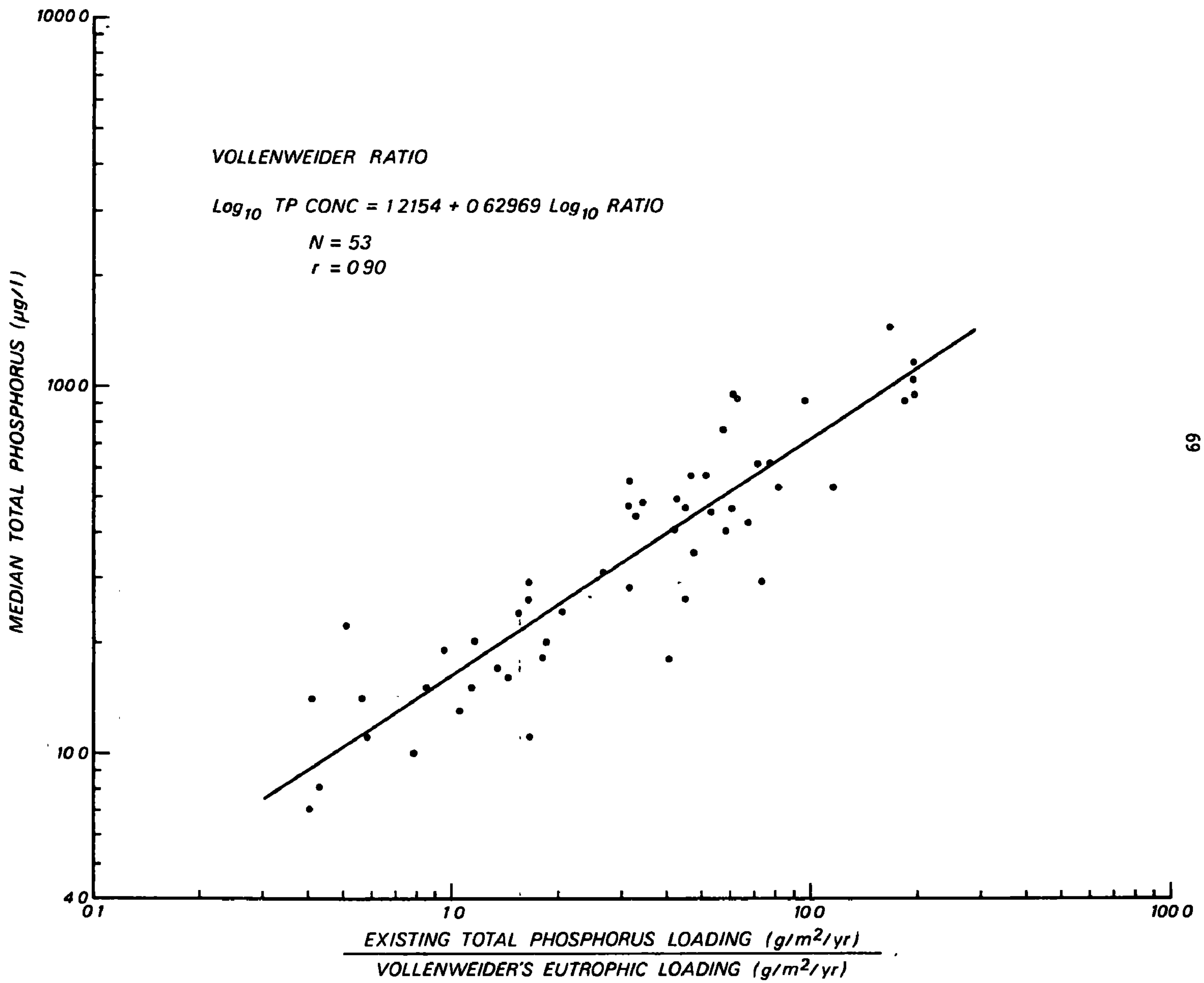
Another way of assessing the validity of the NES stream phosphorus loading data is by using loading models with the NES data to evaluate the relationships between tributary phosphorus loads or concentrations and the in-water-body phosphorus concentrations. For this exercise, we used a data set of 53 NES water bodies in the southeastern states and the input-output model of Vollenweider (1975) and the conceptually-similar models developed by Dillon (1975) and Larsen and Mercier (1976). For brevity, we describe below only the use of the Vollenweider model as an illustration of the application of all three models.

First, we converted the absolute total phosphorus loadings of the 53 water bodies, in grams of total phosphorus per square meter of surface area per year, to ratios by dividing the measured loadings by Vollenweider's eutrophic loadings. We then regressed the logs of the median in-water-body total phosphorus concentrations on the logs of the loading ratios and determined the coefficient of correlation (r). Using the Vollenweider model, r = 0.90 (the regression equation and the line of best fit are shown in the graph on the following page).

Similar regressions were calculated for the other two models. With the Dillon model, r = 0.93, and the regression equation is $\log_{10}$TP concentration = 1.2722 + 0.91086 $\log_{10}$ratio. With the Larsen-Mercier model, r = 0.94, and the regression equation is $\log_{10}$TP concentration = 1.2566 + 0.90778 $\log_{10}$ratio.

Further, in his assessment of phosphorus models for lake management, Reckhow (1977) utilized the NES data on 64 water bodies north of 40° latitude that were sampled in 1972 and 1973. In his critical evaluation of these data, Reckhow stated (chap. 3, pg. 9) "...it is interesting to find that despite the still uncertain impact of hydrologic budget changes on the nutrient concentrations of some lakes, and the possible violation of the steady-state assumption for some lakes, the correlation between the log of the outflow [median] total phosphorus concentration and the log of the lake median total phosphorus concentration is .96..."

These high coefficients of correlation indicate that if the NES phosphorus loadings are significantly in error, the errors are consistent in magnitude and direction, at least for the tributaries and outlets of the 117 water bodies included in the two data sets discussed above. Further, if the loadings are in error, then the in-water-body phosphorus concentrations must also be in error in the same direction and to the same or very similar degree (a possible but unlikely coincidence).


VOLLENWEIDER RATIO
Log10 TP CONC = 1 2154 + 0 62969 Log10 RATIO
N = 53
r = 0 90
MEDIAN TOTAL PHOSPHORUS (µg/l)
1000 0
100 0
10 0
4 0
0 1
1 0
10 0
100 0
EXISTING TOTAL PHOSPHORUS LOADING (g/m2/yr)
VOLLENWEIDER'S EUTROPHIC LOADING (g/m2/yr)

Also, since the water body phosphorus concentrations were determined at EMSL-Las Vegas, and the tributary concentrations were determined at CERL, the correlations suggest a high degree of association between the phosphorus measurements made at the two laboratories.

F. Wastewater Treatment Plant Effluent Nutrient Loads -

During the Survey, from five to 14 effluent samples and corresponding flow data were obtained from 801 municipal wastewater treatment plants in 47 states. However, we have found reports of nutrient data by others for only 16 of those plants, including six for which the times of sampling differed from those of the NES by as much as seven years. Also, in the reports on four of those plants, neither the number of samples nor the kind of samples (e.g., grab or composite) are indicated; and for 11 of the 12 remaining plants, the NES data are based on from two to 14 times more samples. Further, the reported data were obtained during sampling periods ranging from one day to a maximum of four months, whereas the NES data resulted from monthly sampling for a one-year period.

Using the data reported, we have computed annual nutrient loads and have compared those loads to the NES loads. The comparisons are on file at CERL, but because of the limitations noted above, the similarities or differences between the loads are of questionable significance at best. However, recently we have evaluated the data resulting from the effluent sampling at the 801 wastewater treatment plants, and the results are in good agreement with the expected values.

Of those sampled, 702 plants had a variety of conventional treatment processes but were neither affected by phosphate detergent bans nor included tertiary phosphorus removal, 42 plants were in the state of New York where a phosphate detergent ban was in effect during about half of the sampling period, and 25 facilities were in Indiana where a state-wide phosphate detergent ban was in effect during the entire sampling period. The remaining 32 plants included tertiary phosphorus removal processes.

The median effluent total phosphorus load of the 702 plants was 1.0 ± 0.04 kg/capita/year which is midway between the 0.8 kg/capita/year reported by Vollenweider (1968) and the 1.2 kg/capita/year reported by Bartsch (1972). The median effluent total phosphorus load of the Indiana plants was 0.5 ± 0.10 kg/capita/year as would be expected since phosphate detergents account for about half of the phosphorus load in sewage (Anonymous, 1970; Sawyer and McCarty, 1967). The median per capita effluent phosphorus load of the New York plants was midway between the no-ban plants and the total-ban Indiana plants at 0.7 ± 0.10 kg/capita/year.

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APPENDIX

APPENDIX F

SCIENCE ADVISORY BOARD
ECOLOGY ADVISORY COMMITTEE
ADVISORY STATEMENT

THE NATIONAL LAKE SURVEY PROJECT

The Ecology Advisory Committee of the Science Advisory Board recognizes that the National Lake Survey Project has served an admirable purpose in supplying characterization of some 800 lakes and reservoirs in the contiguous United States. The National Lake Survey Program was conceived originally as the Office of Research and Development's contribution to a policy paper being developed by the U. S. Environmental Protection Agency on possible requirements for municipal wastewater treatment plants to remove phosphate from sewage by processes beyond secondary treatment. The purpose of this requirement would be to prevent the accelerated eutrophication of water bodies related to the nutrient content of effluents discharged from those treatment plants. In order to carry out this program, data were collected from the States on lakes and reservoirs that have various types of eutrophication problems. The relationship between the locations of these lakes and reservoirs and the location of the discharge from the sewage treatment plants, either directly into the lakes and reservoirs or into feeder tributaries into the lakes and reservoirs, was a major factor in the selections for survey.

A crash program of sampling of water chemistry and plankton productivity in as many lakes and reservoirs as possible was undertaken in order to identify those that are limited in productivity by nutrients or abiotic factors. In addition, of those lakes associated with a sewage treatment plant as a sole point-source nutrient input, the degree of tertiary treatment (selective nutrient removal) necessary to "stabilize" the productivity of a water body and possibly lead to a reversal of the process symptomatic of cultural eutrophication might then be projected.

At approximately the same time, the Agency was required to respond to the Congress on certain initiatives in the restoration of eutrophied lakes and impoundments under other legislative mandates. Information gathered for the National Lake Survey program paralleled information needed for Congresionally mandated reports. The Lake Survey Program, therefore, acquired an additional purpose.

Initiated in 1972, this Survey of more than 800 bodies of water in the contiguous United States will be concluded in late 1975 upon the completion of the sampling of the western sector of lakes and reservoirs. Data analyses will require one more year. It is recognized that because the Survey is a crash program, conducted over a relatively short period of time and with a limited sampling program, the data obtained will be relatively crude.

October 23, 1975

The Committee states further that because of the non-random selection of the lakes and reservoirs and the limited sampling program of limnological parameters, the results of the Survey must be viewed with some caution. The Committee has severe reservations about the suitability of the National Lake Survey data for extrapolation and generalization. There is a concern that premature evaluation of these data may lead to incorrect conclusions and result in bad management practices.

In order to strengthen the credibility of the study, the Committee recommends that:

- The National Lake Survey data should be compared with existing data on the many well-studied lakes of similar type.
- The comparisons of the results should be discussed in personal conference with limnologists who have collected and assessed data on the same or similar lakes and impoundments covered by the National Lake Survey.
- The National Lake Survey estimation techniques should be applied to data already available on additional well-studied lakes and impoundments and those results should be compared. This will enable one to test the degree of error one may expect to find and thus provide an evaluation of the reliability of the Survey itself.
- Only after such comparison should further efforts at extrapolation and generalization through the computer be carried out.